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ERRATUM

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Some Anguilliform Fishes of Ceylon

BY

P. E. P. Deraniyagala, M.A. (Cantab), A. M. (Harvard)

2nd Assistant Marine Biologist, Fisheries Department

WITH TWELVE PLATES

This paper deals with some Ceylon eels collected from lagoons, coral reefs and from the pearl banks in the Gulf of Mannar as well as from fresh water. Four species are from fresh water and twenty-five are brackish or marine forms, many of which have not been reported previously from Ceylon. These are denoted by an asterisk. The Sinhalese names, with English interpretations where possible, are given after the scientific names. Under "distribution" the localities of capture are given with the name of the province in brackets. For a complete synonomy see Weber and Beaufort (1916) and Herre (1923). I desire to offer my sincere thanks to Messrs. J. R. P. Perera, J. Warren Walker, D. Obeyesekere, Mudaliyar J. E. Perera and Dr. P. E. Pieris of the Civil Service, for kindly assisting me with specimens.

Order **SYMBRANCHIA**[1]

Mouth bordered by intermaxillaries, paired fins absent, gill openings confluent ; ovaries possess oviducts.

Sub-order HOLOSTOMOIDEA

Pectoral girdle joined to skull. Pectorals absent.

Family **Synbranchidae**

Body with a few rudimentary cycloid scales or none. A single ventral gill opening. Gill arches well developed. Cloaca located far back. Tail short. Dorsal and anal rayless folds of skin, caudal with rays.

1. The relationships of this order to other fishes are unknown, but it is possible that the Symbranchia are distantly related to the Apodes. Until further light has been thrown on the subject this order, of which *S. bengalensis* is the sole representative in Ceylon, is placed with the 'Anguilliform fishes."

Synbranchus bengalensis (Mc Clelland)

Local name. *Potta Andha* (*Blind eel*). (Plates I and IV)

Anterior nares openings at tip of snout, posterior nares openings on top of head over eyes. Body elongate. Tail compressed, short and tapering to a fine point. Cloaca in posterior half of length. Lips heavy and reflected over both jaws. Eyes small and sub-cutaneous. The throat is very prominent and fleshy and deeper than the upper part of the head, which has a flat profile. Rays present in caudal fin only.

Colour. The head is reddish brown and mottled. The body colour is olive brown, speckled with irregular dark brown markings.

Measurements. Body 6·25 to 6·75; tail 2 to 2·75, eye 12 to 17 and is above the anterior third of gape. Interorbit 1·25 to 2. Gape 2·9 to 3·6. Caudal fin has 4 to 6 rays. LL present. Length 493 mm.

Teeth. Intermaxillary teeth small and in a single row which becomes pluriserial anteriorly where the teeth are stouter. Maxillary teeth are in a single series and are stronger than the intermaxillary and form a double series anteriorly. The mandibular teeth are stoutest and lie in a single row which forms a pluriserial triangular pattern of finer teeth at the symphysis. (Plate I, fig. 1).

Distribution. In fresh and brackish water. Dehivala paddy fields, Dummala Modera Ela (Kalutara South), Kelaniya, Dig ela (Kehelvatta), (W.P.).

Ceylon, India, New Guinea, Philippines, Siam, Malay Archipelago, Dampier Archipelago.

Order APODES

Mouth bordered by maxillaries, intermaxillaries greatly reduced and fused to form a single plate. Ventral fins absent. Gonoducts reduced to pores. Eyes subcutaneous.

Key to Families.

A. Vertical fins covered with thin skin, pectorals absent or present (*Enchelycephaloidea*).

(a) Narrow scales on body. Pectorals present. . .*Anguillidae* [1]

(b) Posterior nares holes in head. Pectorals present, vertical fins confluent.

(a¹) Teeth strong canines, vomerines large compressed. Jaws overshot, tongue adnate, dorsal on trunk. . . . . *Muraenesocidae*

1. Only family possessing scales.

(b[1]) Teeth weak, jaws level, tongue free, dorsal on trunk........................*Congridae*

(c[1]) Dorsal only on tail and partially suppressed as is anal, jaws undershot, tongue adnate. ....*Moringuidae*

(c) Posterior nares slits in upper lip. Pectorals absent or present.

(a[1]) Caudal present ....*Echelidae*

(b[1]) Caudal absent, tip of tail fleshy, conical ....*Ophichthyidae*

B. Vertical fins covered with thick skin, pectorals absent (*Colocephaloidea*).....................*Muraenidae*

Sub-order ENCHELYCEPHALOIDEA

Scapular arch free from skull, pectorals present or absent, vertical fins with numerous rays covered with thin skin.

Family **Anguillidae**

The characters of this family, which consists of a single genus, are as follows :—

Head conical with gape reaching below the eye or beyond it.

Anterior nares tubate, posterior nares openings in front of eyes.

Eyes subcutaneous. Lips thick, fleshy and reverted. Jaws undershot, teeth small and in cardiform bands, tongue free. Gill openings vertical slits below insertion of pectoral fins. Origin of dorsal fin posterior to gill clefts by more than half a head length. Dorsal, caudal and anal fins well developed and confluent. Body cylindrical, tail compressed. Cloaca in the anterior half of length.

This is the only family in the Order Apodes which is covered with scales. These scales are small, narrow and oblong, placed at right angles to each other to form a zig–zag pattern.

Lateral line distinct.

Catadromous fishes. Adult Anguillidae journey down to the sea during the rains and are then taken in fish kraals at the river mouths and in bamboos which are baited through holes cut in each joint and sunk to the bottom, whereas the young elvers of the level finned species ascend the rivers from the sea in the latter part of May and up to the early portion of December.

Key to species of the genus Anguilla

A. Dorsal overlaps anal by more than half head length.
Edentulous grooves in teeth bands.
............................*A. elphinstonei.*

B. Dorsal barely overlaps or immediately above cloaca.
No edentulous grooves in teeth bands.

(*a*) Eye 6–7·5. Gape does not extend beyond eye. ....*A. spengeli.*

(*b*) Eye 8–13. Gape extends beyond eye.
..................................*A. bicolor.*

***Anguilla elphinstonei** Sykes (Plates I and V)

Local names. *Polon andha—Russel's Viper-like eel (Sab. P.)*
Pol mal andha—Coconut flower eel (Kandy).[1]
Pulli andha—Spotted eel (C.P. and W.P.)
Kabara andha—Blotched eel (W.P.)
Kaha andha—Yellow eel (W.P.)
Veli andha—Sand eel (S.P.)

Gape extends well behind eye. Snout blunt and flattened. Lips thick and in old specimens nearly cover one eye. Vertex well defined. Dorsal fin overlaps anal by more than half a head length and extends at times up to half length of trunk but never further.[2] *A. elphinstonei* is the largest Ceylon eel and a specimen from Levella measured 1,165 mm. and weighed 6,840 grs. when taken. Ceylon specimens of this eel appear shorter and thicker than the Indian ones on view in the Madras and Bangalore Museums.

Colours. Ground colour of living specimen is yellow ochre with dark olive reticulations which may coalesce to form marmorations. Caudal fin has a dark outer edge. Dorsal has a light yellow edge.

Measurements.[3] Head 6–8·25; eye 9·5–14; interorbit 1·5–2·9; snout 5–6. Gape 2·75–3; depth 9–17; pectoral 2·5–3;75; origin of dorsal to gill opening 0·9–1·25 times head length. Origin of dorsal to cloaca 0·73–1 times head. Lateral line present. Length 1,165 mm.

Teeth. Maxillary row bordered externally by a row of fine teeth, internally by an edentulous groove which has along its inner edge another set of fine teeth which are three deep anteriorly, but in a single

1. This eel is known to the Philippinos as "flower eel."

2. Günther reports *A. mauritiana* from Ceylon. This specimen is probably *A. elphinstonei*. The former variety is closely allied but the dorsal overlaps the anal by half a trunk length or more. Where-as in *A. elphinstonei* it is half a trunk length or less.

3. Measurements are "Body" = snout to cloaca, "Trunk" = gill to cloaca, "Tail" = cloaca to caudal, "Head" = snout to gill cleft. "Trunk," $= \frac{\text{trunk}}{\text{head}}$, "Tail" $= \frac{\text{tail}}{\text{head}}$ "Head" $= \frac{\text{Total length}}{\text{head}}$ "Depth" $= \frac{\text{Total length}}{\text{depth}}$, "Depth" is depth of trunk. Snout, eye, gape and pectoral are in fractions of "Head." Interorbital space is in eye diameters.

row posteriorly. Intermaxillary vomerine patch rhombic, anteriorly elongate, pointed posteriorly and often reaches as far back as the maxillaries. Mandibulars similar to maxillaries (Plate I, fig. 3).

Distribution. This eel is comparatively rare near the coast and adults are probably only taken near river mouths when swept down by floods or when migrating. About ten miles inland would seem to be the external limit for the species, which is common in mountain streams where it lurks in deep pools found at intervals in such torrents.

Kelaniya, Beira Lake, Digela, Kehelvatta, Horaïtuduva (W.P.), Ratnapura (Sab. P.), Batulu Oya (N.W.P.), Vakvella, Menikganga, Kumbukkaṇ Oya (S.P.), Mahavelliganga at Levella (C.P.) and Alutnuvara (U.P.).

Ceylon, India, Burma, Andaman Islands, Java, Celebes.

Reproduction. Five specimens taken from localities within fifteen miles of the coast, consisted of two males and three females and ranged from 400 mm. to 500 mm. in length. However, four large[1] individuals ranging from 900 mm. to 1,165 mm. in length, which were taken from inland mountain streams were all females with immature ovaries, whereas one of 350 mm. was a male with undeveloped gonads.

The elvers of *Anguilla elphinstonei* had not been obtained in any Ceylon collections until August 23rd and 25th, 1927, when a few specimens of the young of this eel were taken from the Kumbukkan Oya and Menikganga in the Southern game sanctuary, and in October, 1927, from Digela, Kehelvatta near Moratua (W.P.).

The specimens ranged from 68–89 mm. and, although totally pigmented, were very light in colour with a single irregular row of large diffuse, stellate melanophores along the lateral line of the tail. The origin of the dorsal fin was 0·8 head lengths in advance of the anal fin and this feature, together with its lighter hue, afforded an easy means of separating this species from the darker, level finned varieties.

Anguilla bicolor Mc Clelland[2] (Plates I and VI)

Local names. *Kakuttu andha—Crab eel, (Gampaha)*
Mada andha—Mud eel, (Galle)
Kalu andha—Dark eel, (Colombo)

The gape extends beyond orbit which is small. The head is somewhat flat and has the vertex well defined. The end of the caudal fin

1. The abundance of large females is probably due to many of these eels returning to fresh water after spawning instead of dying of exhaustion in the ocean, as appears to be the fate of the other species.

2. *A. bicolor* has been confused with *A. australis* Rich. by many workers, although Günther draws special attention to the fact that in the latter the vomerine band of teeth is shorter than the maxillary band and broader. The gape does not extend beyond the eye in *A. australis* but in specimens of *A bicolor* 350 mm. and over it extends considerably further.

is not so well developed as in *A. spengeli* but is rounder and fuller than in *A. elphinstonei.*

Colour. The fish when in water is coloured light blue dorsally, brown on the sides shading from pale cream ventrally in the immature, to bright gamboge yellow in the adult. The nasal tubes are yellow. The pectoral fins are transparent. On removal from water the blue is replaced by dark brown and the transparent pectorals darken.

Measurements. Head 6–8; eye 8–13; interorbit 2–2·5, gape 3–3·5; pectoral 3–4; origin of dorsal slightly in front of cloaca. Depth 14–17. LL present. Length 617 mm.

Teeth. No edentulus groove in either jaw. Maxillary teeth are in broad, solid lanceolate bands tapering posteriorly. Intermaxillary and vomerine band tapers posteriorly and reaches level with the posterior extremities of the maxillary bands. In old specimens this band is wider than in young ones and reaches even further and coalesces anteriorly with the maxillary bands, whereas young specimens show a pronounced differentiation. Mandibular teeth form broad lanceolate bands tapering posteriorly. (Plate I, fig. 2).

Distribution. A. bicclor is a common fish and, although essentially a fresh water form, can under stress of circumstances, adapt itself to conditions of intense salinity and exists in salterns at Palutupana along with *A. spengeli.* Its preference for fresh water is shown in that it is absent from brackish water when it can escape up rivers, *e.g.* the brackish portion of Negombo Lagoon, although harbouring plenty of *A. spengeli*, has seldom yielded any *A. bicolor* even though the salinity is much lower than at Palutupana. The fish is common in inland waters but is rare in hilly country. It has been taken at Colombo, Dehivala, Kelaniya, Gampaha, Pasyala, Horaituduva (W.P.), Dedduva Lake (Bentota), Hikkaduwa, Galle, Weligama, Palutupana, Menikganga, Kumbukkan Oya (S.P.), Yodhaveva (Murungan), (N.W.P.), Kegalla (Sab.P.), and at Point Pedro (Jaffna), (N.P.).

Ceylon, Philippines, Natal, East Africa, Mozambique, East India, South Pacific Island, Malay Archipelago, South New Guinea, Samoa, Tahiti, North West Australia, Burma, Malabar, Bombay.

***Anguilla spengeli** Weber. (Plate VII)

The gape does not extend beyond the large eye. The head is conical, tapering to a rather short sharp snout. The vertex is not defined.

The caudal fin is well rounded and better developed than in the other species.

Colour. Colour in life is dark brown above with characteristic metallic bronze on sides and light below. The anal fin is pink, dorsal brown, caudal black. The eye is a dark golden brown.

Measurements. Head 6·75–7·1; eye 6–7·5; interorbit 1·1–2·2; gape 3·7–4. Depth 14–16. Pectoral 2·5–2·75; origin of dorsal above cloaca. LL present. Length 522 mm.

Teeth. No edentulous groove in either jaw. Maxillary teeth are in two solid, broad, lanceolate bands, which taper posteriorly. Intermaxillaries and vomerines form a broad band anteriorly which in some specimens is pentagonal, extending posteriorly as a narrow band almost as far as the ends of the maxillaries. The pentagon is separated from the maxillaries by distinct interspaces. The mandibular teeth are in lanceolate bands tapering posteriorly to acute points.

Distribution. This species is common along the coast where it usually infests brackish water and is also found in large numbers in the salterns or "laivaya" at Palutupana (S.P.), where the water is abnormally alkaline and of very high salinity. It also inhabits rivers and has been taken at Palutupana, Hikkaduwa, Horatudua (S.P.), Dehivala, Negombo (W.P.), and Marichchukaddi (N.W.P.). The specimens from Negombo had nematodes in the stomach, whereas those from other places were uninfested.

Ceylon, Nias, Java, Borneo, Philippines.

Reproduction. A male 362 mm. long was kept with others in a cement tank since June 20th, 1927, and by November 7th, 1927, had assumed a silvery hue throughout its entire body and fins which gave it a ghost-like appearance as it glided among its darker companions. Three days later it was transferred to a glass aquarium where, under the influence of sunlight, it reverted to its former colour of brown and bronze and continued to feed normally until November 16th, when it was killed and examined. After death the pectorals turned black and only a suggestion of the silver colouration remained.

The testes lay as a flat band on either side, behind the intestine. Both consisted of numerous, uniform, flat, lobe-like leaflets which were so arranged that the posterior edge of each overlapped the anterior edge of the one behind it, when viewed dorsally.

A female 558 mm. long, taken in the fish traps at the mouth of Negombo Lagoon on November 25th, 1926, had developed ovaries. Another female 520 mm. long was taken on a hook baited with worm near the sea end of the Beira Lake, Colombo, November 27th, 1927.

The fresh, dead, specimen showed traces of bronze sheen but the silvery lustre was well in evidence, while the pectorals were jet black.

The eye was 8 in head, the body depth 14·44 in entire length. The ovaries were developed and lay on either side of the intestine as thin, convoluted, wide, ribbon shaped bands of a pale creamy colour. The internal surface of each ovary lay next to the intestine and was smooth, showing numerous vertical blood vessels which were arranged parallel to each other, whereas these were not evident on the outer side of the ovary which was rugose, being thrown into numerous vertical folds, each of which consisted of several, elongate, islets which were full of ova. These ova could easily be separated out with a needle under the naked eye and were 0·26 mm. in diameter, and had no oil globule.

The fat bodies which lie in bands, close to the intestine, were greatly reduced but the animal was well nourished.

Anguilla larvae. The Leptocephalus[1] stage of Ceylon Anguillidae has yet to be discovered. Pigmentless elvers have been taken at sea on the Pearl Banks, Gulf of Mannar on November 7th, 1926, measuring 46·8–58 mm. in length.[2]

Pigmented ones were taken at the Pinketti veva "spill" in Batulu Oya, (N.W.P.,) on November 26th, 1926, and measured 54–56·5 mm., while shoals of elvers were noticed on September 24th, 1927, on the sea side of the lock gates to the canal connecting the Beira Lake with the Colombo Harbour and appeared in numbers till November 5th, while stragglers continued as late as December 8th, 1927. These translucent elvers were mostly unpigmented, but a few showed stellate melanophores on the top of the head, along the lateral line, between the myomeres of the tail above the lateral line and internally along the vertebral column.

The pigmentless elvers ranged from 51–58 mm., while sixty elvers which were taken a week after they entered fresh water although well pigmented only ranged from 48–54 mm. in length. In these elvers, which were either *A. bicolor* or *A. spengeli*, the origins of dorsal and anal were almost level or that of the former was slightly in advance of the latter. The gape did not reach beyond the eye and the lower jaw was more markedly undershot than in the normal adult. Since 1927 the harbour side of the lock gates were daily examined for elvers and the first individuals for 1928 were a single level finned specimen on May 17th, 1928, and two on May 18th, 1928, which were 50, 51·5 and 52 mm. in length and unpigmented, but none were taken from May 19th to July 10th. On July 13th larvae of the level finned eels reappeared in large numbers.

1. *Leptocephalus* is correctly applied to designate a genus of *Congridae*.
2. See addendum, page 29.

Family Muraenesocidae

Pectorals well developed. Anterior nares tubate and behind constriction of intermaxillary; posterior nares openings in front of and level with the middle of each eye. Jaws overshot. Teeth in front of jaws strong canines, middle vomerines in a long band and are large, pointed and compressed. Tongue adnate, palatopterygoid well developed. Caudal vertebrae without transverse processes.

Muraenesox cinereus (Forskål). (Plate III, fig. 1. Plate II, fig. a).

Local names. *Puliviya (Chilaw)*
Mudhu luhula—Sea Ophicephalus (Negombo)
Vel luhula—Rice field Ophicephalus (Negombo)
Mudhu theliya—Sea Mastacembelus (West and South Coasts)

Eyes rather large and placed over the hinder half of gape. The anterior nares are tubes, posterior are rimmed oval holes in advance of the eyes and in line with them. Rather well defined constriction exists posterior to intermaxillary plate giving upper jaw a resemblance to that of a crocodile.

Colour. (Fresh dead specimen). Back leaden blue, sides silvery white. Pectorals orange, dorsal and anal with dark outer margin.

Measurements. Body 2·5 to 2·9; tail 3·5 to 4·5; depth 22–25, eye 8·5 to 9·5; eye 2·5 to 2·75 times into snout. Interorbit 1, gape 2·25 to 2·75, pectoral fin 3 to 4. Origin of dorsal is 1 orbit ahead of insertion of pectoral. LL present. Length 1,500 mm.

Teeth. Maxillary teeth are in a single row, close set and pointed, spreading out into several rows posteriorly and bordered externally by a row of fine teeth. Peripheral teeth of the intermaxillary plate are large, long, conical and about ten in number. There are about 4 small teeth on the intermaxillary plate. The vomerines are in three series. The middle series consists of about 10–12 large compressed acute teeth which are tricuspid. In each tooth the two external cusps are much inferior to the median one which rises well above them to form a formidable fang. There is a single bordering row of fine teeth on each side of these large compressed tricuspid vomerines.

There are three series of teeth in the lower jaw. At the symphysis there are about 6 strong canines enclosed by about 6 weaker and smaller teeth. The mandibles contain three rows of canines, of which the middle row are close set and strong, whereas they are bordered internally and externally by a set of fine teeth. All the teeth are upright and not directed outward.

Two oval patches of fine close set granular teeth are placed on the pharyngeals. (Plate II, fig. a.).

Distribution. Found in brackish and salt water and is in considerable demand as food, being commonly seen in the markets of Chilaw and Puttalam, while numbers of small specimens are taken in shrimp nets set in the Negombo Lagoon. At Kalpitiya it is salted and dried and sold as " Karavala," and is converted into "Jadi" elsewhere. It is also common in the Harbour at Trincomalie and in many lagoons, estuaries and shallow sheltered inlets of the sea.

Puttalam, Chilaw, Negombo, Colombo, Kalutara, Balapitiya.

Ceylon, Red Sea, Estuaries of India, Malay Archipelago, Australia, Philippines, Japan, Sumatra, Java, Borneo, Celebes, South New Guinea, Penang, China, West Pacific Islands, East Africa.

Family **Congridae**

Pectorals well developed. Anterior nares tubate near tip of snout. Posterior nares openings in the horizontal through middle of eye. Jaws level. Teeth weak, vomerines in a short band. Tongue free. Palatopterygoid well developed. Caudal vertebrae with transverse processes.

Key to Congridae

Outer teeth close set to form a cutting edge.

................*Leptocephalus.*

Outer teeth do not form a cutting edge.

...................*Ariosoma.*

* **Leptocephalus cinereus** (Rüppell). (Plate III, fig. 2. Plate II, fig. b).

Local name. *Mudhu andha—Sea eel*

The head sharp and pointed, jaws overshot, lips reflected, masseter muscles well developed. Anterior nares are tubes at the tip of snout and point downward. Posterior nares are holes on front margin of orbits and level with mid orbit. Gill opening large. Tongue large, free, edentulous. Heart immediately behind gill opening. Pectoral fins are well developed.

Colour. Dark brown dorsally, paler ventrally with pale vertical fins bordered with black, pectorals with black tips.

Measurements. Body 3; tail 5; depth 19; eye 7·5; eye 1·7 into snout; snout 4; gape 2·6; pectoral fin 3·5; origin of dorsal fin is 1·5 eye diameters behind gill opening but well in front of tip of pectoral fin. Lateral line present. Length 920 mm.

Teeth. Outer maxillary teeth in a single row set very close to form a cutting edge, but expand anteriorly into several rows and unite with the intermaxillary—vomerine patch of numerous cardiform teeth. A single row of minute teeth border the maxillaries internally. Mandibular teeth are similar to the maxillaries and expand into many rows anteriorly but do not unite at the symphysis. (Plate II, fig. b).

Distribution. Taken in Galle Harbour on line. Found near reefs.

Ceylon, Celebes, East Africa, Red Sea, Mauritius, Malay Archipelago, Sumatra, New Guinea, Java, Samoa, Sandwich Island, Lord Howe Island.

* **Ariosoma anago** (Schlegel) (Plate II, fig. c).

Jaws overshot. Pectoral fins well developed, gill slits large and vertical. Four large sense pits on snout. Anterior nares tubular, posterior nares holes, level with and anterior to middle of orbit.

Colour. Pale brown dorsally with silvery sides, fins hyaline.

Measurements. Body 2·5 to 3; tail 3·1 to 4; head 5–6; depth 2·25 times into head; depth 6 to 7 times into body; depth 8 to 9 times into tail; eye 3·5 to 4; gape 4. reaches to about mid orbit; pectoral fin 2·5 to 3. Length 180 mm. The origin of dorsal fin is above the insertion of pectorals ; it is low near its origin and increases in height posteriorly. LL present and has 42 sense pits anterior to cloaca.

Teeth. Small and pointed, but do not form a cutting edge. Maxillary teeth in rows of two or three anteriorly tapering off posteriorly. Intermaxillary patch merges into vomerine patch which tapers out to a point posteriorly. Mandibular teeth pluriserial anteriorly tapering to a single series posteriorly. (Plate II, fig. c).

Reproduction. Three gravid females were taken at night in a dip net at 8.30 p.m., February 13th, 1925, from Twynam's Paar in the Gulf of Mannar at Silavaturai reef beacon at a depth of 4·5 metres on a bottom of sand and coral. The ova were 0·6 mm. in diameter when examined after being in 5% Formol. for two years.

Eight gravid females were taken similarly on March 5th, 1926, in the Gulf of Mannar and preserved in 5% Formol. The ova were 0·6 mm. in diameter when examined two years later. Locality of capture was 2 miles NNE. of Arippu reef beacon, depth of sea 4·8 metres, sea bottom mud.

Distribution. A common variety, taken at night with a dip net on the Pearl Banks, Gulf of Mannar. Found in the open sea.

Ceylon, Coromandel coast of India, Singapore, Celebes, Japan, Malay Archipelago.

Family **Echelidae**

Pectorals present or absent. Anterior nares tubate, posterior ones in upper lip near eye, under covering flaps. Jaws overshot. Teeth small. Tongue adnate. Palatopterygoid well developed. Caudal vertebrae with transverse processes.

* **Muraenichthys gymnopterus** (Bleeker) (Plate VIII, fig. 1. Plate II, fig. d).

Gill openings small. Branchiostegals of right side overlap those of the left side. Anterior nares tubular, posterior nares in slits, both nares in margin of upper lip. Pectorals absent.

Colour. Small eels of a greyish brown colour.

Measurements. Body 3·25; tail 5·2; depth 12·5 into body; depth 20 into tail; eye 12; gape 3; origin of dorsal nearer to anal than to snout by 0·9 head lengths. LL well defined. Length 90 mm.

Teeth. Maxillary teeth form a double row anteriorly but exist posteriorly as a single row. Premaxillary teeth strong and form a circle of about 8 to enclose a single strong mesial tooth ; vomerines blunt and strong, in a double series anteriorly with a single series posteriorly. Mandibulars a single row of teeth with an anterior inner row of six larger teeth on each side. (Plate II, fig. d.).

Distribution. Gulf of Mannar, off Mannar (N.P.) ; off Kudremalai Point (N.W.P.); in Lake Tamblegam (E.P.).

A marine shallow water form.

Ceylon, Philippines, Fiji, China, Java, Celebes, Batu Islands.

Family **Ophichthyidae**

Pectorals present, or absent. Caudal fin absent. Anterior nares tubate, on lip and point downward, posterior nares slits on lip near eye. Jaws overshot. Teeth pointed or granular. Palatopterygoid well developed. Tongue adnate. Caudal vertebrae with transverse processes. Vomerine teeth present or absent.

Key to Ophichthyidae

A. Pectorals absent.

.... *Sphagebranchus.*

B. Pectorals present.

(*a*) Teeth on mandibles and vomer in single series, caniniform. A fringe of papillae on lips.

.... *Brachysomophis.*

(*b*) Teeth of jaws pluriserial, granular, vomerines present. ....*Pisoodonophis*

(*c*) Teeth of jaws in a few rows, conical. Vomerines present. ....*Ophichthus.*

(*d*) Teeth conical. Vomerines absent. .... *Leiuranus.*

* **Sphagebranchus polyopthalmus** (Bleeker) (Plate IX, fig. 1. Plate II, fig. e).

Local name. *Pannu Malu—Worm fish*

Dorsal and anal fins reach nearly to tip of tail which is finless. Origin of dorsal behind gill openings by 0·25 head length. Anterior nares long slits each on a blunt fleshy papilla in upper lip some distance behind tip of snout. Posterior nares slits in upper lip anterior to eye and furnished with a pointed papilla.

There are two pores at tip of snout and in front of eye. Vertical fins very low. Gill openings very oblique, small, close set and ventral, with superior accessory gill membrances. Tongue adnate.

Colour. Body yellowish dusted with brown dorsally leaving a double row of 10 ocelli from snout to origin of dorsal fin. Vertex has a transverse row of about 8 ocelli.

Measurements. Body 4·75 ; tail 4·15 ; eye 13, is in mid gape ; eye goes 2·5 into snout ; depth 27 ; snout 5·5 ; gape 3·25 ; pectorals absent. LL faint with a single row of ocelli on its dorsal side. Length about 240 mm.

Teeth. Uniserial, pointed, form a V-shaped figure on the inter-maxillary plate. Vomerines in a single row. (Plate II, fig. e).

Distribution. These fishes appear in the sand near the mouth of the Kaluganga (W.P.) every December and live chiefly between tide marks. As a wave retreats they thrust their heads out of the sand and, facing the land with open mouths, snatch up particles of food. When the wave dies out they sink back into their burrows. Their presence can readily be detected by the sharp "V"-shaped wave lines caused in the thin film of water where it abutts against the tips of their snouts. They bore down tail first into moist sand with amazing celerity and fast digging is necessary to capture them when required as bait. An estuarine form. Kalutara (W.P.), Chilaw (N.W.P.).

Ceylon, Sumatra, Nias, Java, Samoa, Tahiti.

Sphagebranchus orientalis (Mc Clell.) (Plate II, fig. f).

Local name. *Otaliya.*

Dorsal and anal fins low. Gill openings oblique slits placed ventrally converging anteriorly and possess superior accessory membranes. Anterior nares are placed in low, wide, fleshy papillae on the lower surface of the snout. Posterior nares slits in the upper lip in advance of eye level and denoted by a papilla. Head depressed with the lower jaw rather wide ; jaws well overshot, giving the flat head a shark-like appearance. Origin of dorsal fin immediately over hind end of gill. Lateral line present.

Colour. Yellow with a brownish dorsal aspect.

Measurements. Body 4·6; tail 4; depth 34·4; eye 20; snout 4 pointed and depressed, gape 3·5; pectorals absent. Length 369 mm.

Teeth. A single series on the maxillaries with a set of pointed, fine strong teeth on intermaxillary plate. The vomerines are either in a double series anteriorly tailing off to a single series or exist only in a single series. The mandibulars are in a single series. (Plate II, fig. f).

Distribution. Burrows in sand along the shores of inlets and bays. Ceylon, Madras, Bay of Bengal up to Orissa, Philippines, Madagascar, British New Guinea.

***Brachysomophis (Brachysomophis) cirrhochilus** (Blkr.) (Plate XII)

Local names. *Mudhu polonga—Sea polonga*
Ran theliya—Golden muraenesox

Head conical. Jaws slightly undershot. Gape reaches far behind the eye. Anterior nares in short tubes, posterior ones immediately behind in slits in lip. A series of bifid, fleshy, papillae fringe both lips. Several sets of large sense pits on head. Gill slits large with membraneous posterior half.

A series of well defined grooves all over body, run slant-wise dorsi-ventrally. Top of head above gape closely pitted but has no grooves. Origin of dorsal is two-thirds of head length behind gill openings. Distance from tip of tail to end of dorsal fin equals length of pectoral fin.

Colour. (Fresh dead specimen). Body yellow ochre shading into a dirty olive green on the head. Large irregular dark brown blotches on body, commencing dorsally and ending a short distance below lateral line. Pectoral fins brown.

Measurements. Body 4·3 ; tail 5·2; depth 23 ; eye 20; interorbit 1.8; eye 2·5 into snout; gape 2·5. LL present. Length 1,558 mm.

Teeth. Caniniform, decrease in size posteriorly, largest on vomers. Vomerines 10 in a single series. Maxillary teeth in a double series and are finer than the mandibulars which are in a single series.

Distribution. Mannar (N.W.P.)

Ceylon, Formosa, Muscat (Arabia), Amboyna.

***Pisoodonophis cancrivorous** (Richardson) (Plate II, fig. g).

Local name. *Gulliviya—Burrow dweller*

Description. Jaws overshot, six pores along each mandible, tongue adnate. Gape reaches past eye. Origin of dorsal immediately behind gill cleft and 2·8 head lengths in advance of cloaca. Height of dorsal and anal fins is half body depth. Anterior nares are tubate followed by a short papilla. Posterior nares long slits in upper lip and end before reaching eye level. Behind each of these is another pair of papillae. Gill slits lateral.

Colour. The colour in life varies dorsally from olive to almost yellow. Ventral aspect yellow.

Measurements. Body 3·7; tail 5; depth 32–34; eye 10–11; eye 1·6 into snout; gape 3; pectoral 3·2–3·7. LL present. Length 514 mm.

Teeth. There are eight intermaxillary teeth in a cluster. Vomerines equal in size and in a triple row which tapers into a single row posteriorly. The maxillaries are considerably smaller and pluriserial. Mandibulars pluriserial with stronger teeth near symphysis. (Plate II, fig. g.).

Distribution. A burrowing form, from estuarine waters and common in Negombo Lagoon. Attempts to bite when captured.

Ceylon, Arabia, Madagascar, Japan, Australia, Samoan Islands, Philippines, Penang, Singapore.

Ophichthus rutidodermatoides (Bleeker) (Plate II, figs. h,i).

Local name. *Madda pannuva—Mud worm*

Jaws overshot. Gape reaches beyond eye. Anterior nares in tubes, pointing downwards, followed by a pair of solid fleshy papillae behind which are the posterior nares. These are two long slits in upper lip continuing to under anterior edge of eye ; behind each slit is another and shorter papilla. Origin of the dorsal fin almost above the tip of pectoral, but in some cases it is two pectoral fin lengths behind gill cleft. Its height about a third of body depth. Tip of tail finless. Gill slits lateral.

Colour. (In life). Olive brown dorsally merging into pale yellow ventrally.

Measurements. Body 6–7 ; tail 12·6 ; depth 51–67 ; eye 12–14 ; interorbit 1·5 ; eye 2 into snout ; gape 3–3·6 ; pectoral 3–3·9. LL present. Length 684 mm.

Teeth. In young specimens there are three teeth in a single series on the intermaxillary plate. A double row of teeth on maxillaries and mandibulars. Vomerines arranged in a double row which tapers into a single row posteriorly. Older specimens, Plate II, fig. i, carry four teeth on the intermaxillary plate, which are arranged in a trapezoid pattern.

Maxillaries and mandibulars represented by a single row but the vomerines are unaltered. Teeth all conical. (Plate II, figs. h,i).

Distribution. A burrowing form which is common in estuarine waters and is abundant in Negombo Lagoon (W.P), Trincomalie harbour (E.P.), mouth of Kelaniganga (W.P.).

Ceylon, Java, Penang.

* **Ophichthus apicalis** (Bennett)

Jaws overshot, gape reaches hind edge of orbit. Anterior nares wide tubes, posterior ones long slits in lip and each between a pair of papillae, the posterior of which is under anterior margin of orbit. Origin of dorsal above mid pectoral, its height about ½ orbit. Dorsal and anal highest near tip of tail which is finless. Gill slits lateral.

Colour. (In life). Brownish yellow, darker dorsally.

Measurements. Body 3–3·75, tail 4·8–5·5, depth 22·5–27, eye 6·5–8·5, interorbit 1–1·5, eye 1·25 in snout, gape 3·5–3·8, pectoral 2·25–2·5, lateral line present. Length 216 mm.

Teeth. Conical, small, 3–5 in two converging rows on intermaxillary plate. A single or at times a double row on maxillaries, vomerines in a double row tapering posteriorly to a single series and extend, as far back as maxillaries. Mandibulars in single series.

Distribution. A burrowing form common in coastal waters, ascends to surface at night. Often in stomach contents of bottom feeding fishes.

Gulf of Mannar, Wadge and Pedro Banks.

Ceylon, Singapore, Celebes, Philippines, China, Madagascar.

* **Ophichthus altipinnis** (Kaup.)[1]

Jaws overshot, gape reaches hind edge of orbit, anterior nares tubate, posterior nares slits in lip in advance of eye and between two papillae, the posterior of which is shorter and under front of orbit.

1. I have to thank Mr. J. Norman, of the British Museum, for this identification.

Origin of dorsal slightly in front of gill cleft. Dorsal and anal as high as ½ body depth. Tip of tail finless. Gill slits oblique. Large sense pits on head.

Colour. (Formol). Yellowish, fins blue black.

Measurements. Body 3·4, tail 5·8, depth 32·2, eye 9·2, eye 1·6 in snout, gape 3, pectoral 2·9, lateral line placed in upper part of body, well defined. Length 561 mm.

Teeth. A double band of 5 teeth on intermaxillary. A long double band on vomer, stretches further than maxillaries which are uniserial. Mandibulars biserial at symphysis, uniserial posteriorly.

Distribution. A single specimen from the pearl banks, Gulf of Mannar. (Marine).

Ceylon, Celebes, Amboyna

***Leiuranus semicinctus** (Lay and Bennett) (Plate II, fig. k).

Tip of tail finless. Anterior nares tubes on the edge of upper lip, posterior nares slits in edge of upper lip and just in advance of orbit. Jaws very overshot. Origin of dorsal over middle of pectoral fin.

Colour. 22–27 black cross bands which are broader than the interspaces, narrowing and fading ventrally on a body colour of pale cream. In some specimens several of the black bands are not regularly continued on both right and left sides, but interrupted at the dorsal fin and out of line with the pigment of the opposite side. Vertical fins hyaline with the black bands continued into them.

Measurements. Body 7·5; tail 7; depth 16·5 times into body; depth 15·5 times into tail; eye 12·5; interorbit 2; gape 4. Pectorals 6 nearly equal to snout. Dorsal fin begins slightly behind gill opening. Lateral line faint. Attains to a length of 565 mm.

Teeth. A single row on maxillaries. No vomerines. Mandibular teeth rudimentary. (Plate II, fig. k).

Reproduction. Two gravid females were taken at night in a dip net on February 13th, 1925, from Twynam's Paar in the Gulf of Mannar, near Silavaturai reef beacon, at a depth of 4·5 metres, on a sea bottom of sand and coral. They were preserved in 5% Formol. The ova were 0·9 mm. in diameter when examined in 1927. Four gravid females were also taken at night in the Gulf of Mannar on the 17th March, 1927, and contained developed ova. The specimens were preserved in 90% alcohol. The ova were 0·8 mm. in diameter when examined in January, 1928.

Distribution. A very common form in the Gulf of Mannar. Specimens were frequently taken in the dip net after attracting them to the ship's side at night with a light. *Leiuranus* burrows tail foremost into

the sand where it stays with even the snout submerged and its presence is only noticeable by the eddying and bubbling of the sand over its gill openings. A shallow water, burrowing form.

Ceylon, Hawaii, Ishigaka Islands, Riu Kiu Archipelago, Samoa, Sandwich Islands, Japan, Queensland, Fiji Islands.

Family **Moringuidae**

Pectorals present or absent. Dorsal and anal fins confined to tail. Anterior nares tubate near tip of snout. Posterior ones rimmed openings near front of eye. Jaws undershot. Tongue adnate. Heart far behind gill openings.

***Moringua bicolor** Kaup. (Plate VIII, fig. 2. Plate II, fig. 1).

Second dorsal and anal fins confluent with caudal and black with a light centre. The head is larger than the ensuing portion of the trunk, and is under-shot. Pectoral fin round with gill opening located obliquely and laterally. Body fine and cylindrical, lateral line well developed.

Colour. Greenish brown above, yellow or purple ventrally, fins yellowish, caudal black.

Measurements. Body 8·8–10·4 ; tail 3·25–4; tail 3·75 into total length ; tail 2·7 into body ; depth 65–67 ; eye 10–12·6 ; interorbit 1·5 ; eye 1·5 into snout ; gape 5–8, reaches posterior half of eye ; pectoral = 6 = snout. Origin of dorsal is somewhat more than a head length posterior to cloaca. Origins of anal and dorsal level.

Base of first dorsal fin as long as the united second dorsal, second anal, and caudal fin, which last has the lower portion rather longer than the upper portion. ID 32–34, IA 32–34, P 8–9. Length 555 mm.

Teeth. Three strong teeth on each side on the intermaxillary. Vomer has four smaller teeth in a single row. Maxillary teeth weak, present or absent. Eight teeth on each mandibular. (Plate II, fig. 1).

Distribution. Two specimens taken under a light at night, on the Pearl Banks. Found in the sea.

Ceylon, East Flores, Timor, Kandavu, New Britain.

Sub-order COLOCEPHALOIDEA

Scapular arch free, pectorals absent, vertical fins covered with thick skin.

Family **Muraenidae**

Anterior nares tubate, posterior nares openings on top of head before or above eyes, sometimes with a pronounced rim. No pectorals. Palatopterygoid vestigial. Caudal vertebrae with transverse processes.

Key to Genera of Muraenidae

A. Some teeth granular and flat.

.... *Echidna*,

B. Teeth fang-like, smooth.

  (*a*) Lateral line present.

.... *Thyrsoidea*,

  (*b*) Lateral line absent.

    (a^1) Median fins absent

.... *Uropterygius*,

    (b^1) Median fins present
    Depth less than 30

.... *Gymnothorax*,

    (c^1) Median fins present
    Depth more than 35

.... *Strophidon*,

Key to the Ceylon species of Echidna

A, Intermaxillary plate with 8 central teeth,

.... *E. zebra*,

B, Intermaxillary plate with 2 central teeth.

  (*a*) White with 2–3 rows of stellate blotches

.... *E. nebulosa*.

  (*b*) Pale yellow with fine brown mottling

.... *E. delicatula*.

* **Echidna zebra** Shaw (Plate X, fig. 1. Plate III, fig. 3.
Plate II, fig. m.)

Local name. *Vairan Gal-gulla—Striped Muraena*

Head thick and round with lower jaw curved upwards. Eye small. There are on the body, two sets of interfitting sub-dermal bony scutes, laterally ; one set is above the lateral line, the other below it as shown in the figure. (Plate X, fig. 1A.).

Colour. There are 112 yellowish rings on a chocolate coloured back ground.

Measurements. Body 7–8·7; tail 3·7; eye 12–14; interorbit 2–2·6; gape 2·5–3. Vertical fins very low and under thick skin. Length 1,200 mm.

Teeth. Short, round, blunt discs of the "pavement" type. The intermaxillary plate has a cluster of about eight large teeth ringed by a number of smaller teeth. The vomerines are also in a large cluster exceeding the former in number. The maxillary teeth small and few. Mandibular teeth well developed and form three rows anteriorly, two posteriorly. (Plate II, fig. m).

Distribution. On reefs and near the shore.

Ceylon, Samoa, Philippines, Andamans, Burma, Malay Archipelago, China, Tonga Islands.

***Echidna nebulosa** (Ahl.) (Plate X, fig. 2. Plate II, fig. n).

Local name. *Pulli galgulla—Spangled Muraena*

Muzzle compressed and ascends abruptly to vertex. Origin of dorsal in advance of gill slits. Dorsal 4 times as high as anal. Lateral line absent.

Colour. (Alcohol). Pale yellowish brown with two or three rows of stellate blotches having one or more ocelli in the centre. The interspaces are mottled with irregular lines and spots. (In life). The body colour is white with dark brown stellate markings having a yellow centre.

Measurements. Body 4·25–4·5; tail 5; depth 9·5 into body; depth 10 into tail; eye 10·5; interorbit 1·5; eye 1·5 into snout; snout 5·5; gape 3; origin of dorsal in advance of gills. Gill cleft horizontal. Length of specimens examined 187–310 mm.

Teeth. A marginal ring of about twelve teeth on the intermaxillary plate enclosing two strong conical mesial teeth, vomerines in a double series of smaller teeth about eight in number. Maxillaries in a single row, mandibulars in a single row, sometimes two rows in anterior part of jaw. (Plate II, fig. n).

Distribution. It is common in the coral reef at Galle, frequently travelling from pool to pool, over the reef, exposed at low tide to air and light. One was observed to seize a goby much thicker than itself which it commenced to drag into its burrow alive. Taken on reefs near the shore. Galle, Trincomalee.

Ceylon, Honolulu, Samoa, Philippines, Madagascar, East Coast of Africa, Red Sea, China, Hawaii, South Australia, South Sea Islands, Seychelles Archipelago, Sumatra, Celebes, Sulu Islands and New Guinea.

***Echidna delicatula** (Kaup) (Plate XI, fig. 2. Plate II, fig.o).

Four large pores along each maxillary and mandibular. Eye in mid gape. Dorsal profile curved regularly. Origin of dorsal in front of gill opening which is in mid depth. Dorsal and anal fleshy folds. Lateral line absent.

Colour. (Alcohol). Greyish body colour with fine dark mottlings which consist of the union of two or more circular black dots to form irregular blotches and marbling. These blotches increase in size posteriorly. The mask is lighter in colour and has less distinct mottlings than vertex and rest of body.

Measurements. Body 4; tail 5; depth 14·2; eye 8·5; interorbit 1·2; eye 1·25 into snout; gape 3. Length 265 mm. Dorsal and anal low and enclosed in thick skin. Dorsal is well ahead of gill cleft which is small and horizontal. Dorsal fin equals anal in height.

Teeth. There are twelve conical marginal teeth around the intermaxillary plate which has two stout mesial teeth. There is a double row of about eight teeth on the vomers which remain distinct from the intermaxillaries. A double row runs on each maxillary. The outer row is longer and consists of smaller teeth than the inner row. (Plate II, fig. o).

Distribution. The specimen examined was taken on a hook, in the Fisheries Harbour, Colombo, November 7th, 1926. On reefs and near the shore.

Ceylon, Philippines, Riu Kiu Islands, Samoa, Malay Archipelago

Uropterygius concolor Rüppell. (Plate XI, fig. 1. Plate II, fig. q).

Anterior nares tubes, posterior ones with elevated rims. Lateral line absent. Eye in mid gape, gill openings in mid depth, shape subcylindrical, compressed near caudal fin which is rudimentary. This eel is the most degenerate member of the Family having lost its fins.

Colour (of a specimen in Formalin). A uniform reddish brown.

Measurements. Body 3·5; tail 4; depth 21·5; eye 13·5; interorbit 2; eye 1·6 into snout.; gape 3·5; length of single specimen 202 mm. No dorsal or anal visible, faint traces of a caudal fin.

Teeth. The upper jaw has a single strong mesial intermaxillary canine. A row of fine teeth runs along the margin of the maxillaries and intermaxillaries. This is followed by a shorter row of six strong teeth on each maxillary. A row of fine marginals exists in the mandibulars, followed by an inner row of six strong teeth. (Plate II, fig. q).

Distributions. Taken on the Pearl Banks in 1913 and from reefs and shallow water.

Ceylon, Red Sea, Mauritius, Philippines, Australia, Society Islands, Sandwich Islands, Malay Archipelago.

Thyrsoidea macrura (Blkr.)

Origin of dorsal equidistant from eye and gill cleft. Eye nearer to tip of snout than to corner of mouth, pectorals absent. Dorsal and anal covered with thick skin. Gill cleft an oblique slit. Lateral line well marked. Anterior nares tubes on top of snout, posterior nares holes above front of eye. Specimen examined 1,050 mm. Said to attain to 3,000 mm.

Colours. (In Formol). Dark brown, lighter beneath.

Measurements. Body 4 ; tail 5·5 ; depth 33·25; eye 20·8; interorbit 1·5 ; eye 2·2 in snout ; snout 9·4; gape 3·25.

Teeth. Nine peripheral intermaxillary teeth with 4 mesial depressible fangs. Vomerine teeth in a single row or absent. Maxillaries consist of a row of eleven strong teeth on each side behind a single row of 20, smaller teeth. Each mandibular has eight strong teeth extending along its anterior half and an external row of 20 fine teeth along its entire length.

Distribution. The only specimen in the collection was taken from Negombo Lagoon (W.P.). Günther mentions a ten-foot skin from Ceylon. This is the longest Apodal fish known. Inhabits the sea in shallow water and enters lagoons.

Ceylon, India, Malay Archipelago, New Guinea, Andamans, Philippines, Formosa, Pelew Islands, Queensland, Natal.

Strophidon brummeri Blkr. (Plate II, fig. p).

Origin of dorsal midway between eye and gill cleft. Eye over middle of gape. Pectorals absent. Dorsal and anal well developed, dorsal twice as high as anal. Lateral line absent. Anterior nares tubate, posterior ones holes above front of eye, several large pores on both jaws. Specimen examined 375 mm. long.

Colour. (In Formol). Pale dirty white with almost hyaline fins. Anterior part of head with black dots. Fins with white margin.

Measurements. Body 5·5; tail 6·6; depth 37·5; eye 16; interorbit 1·8; eye 2 in snout: snout 8; gape 4.

Teeth. Nine pointed marginal intermaxillaries around 3 mesial depressible fangs. Seven large conical vomerines in a single row. A single row of eleven teeth on each maxillary. Nine teeth in a single row at symphysis. Twelve smaller teeth in a single row on each mandibular. (Plate II, fig. p).

Distribution. The only specimen in the collection was taken at Neeroddumunai, Lake Tamblegam (E.P.).

Ceylon, Malay Archipelago, New Guinea, Madagascar, Mauritius, Japan, Pacific Islands.

Key to the Ceylon Species of Gymnothorax

A. Spots on body about as large as orbit.

(*a*) Light brown with irregular black spots. .... *G. fimbriatus.*

(*b*) Purplish with regular white spots. .... *G. punctatus.*

B. Blotches on body larger than two orbits.

(*a*) White with polygonal chocolate blotches. .... *G. favagineus.*

(*b*) Yellow with irregular russet blotches .... *G. undulatus.*

(*c*) Yellow with three rows of stellate blotches. .... *G. pictus.*

C. Body uniform brown ... . *G. afra.*

Gymnothorax favagineus Bloch and Schneider. (Plate II, fig. r.)

Local name *Kaluiriya—Black lined*

The gill opening oblique, small.

Anterior nares tubes, posterior nares holes above eyes. Both fins under thick skin.

Colours. Polygonal chocolate coloured spots bordered by a white narrow reticulation.

Measurements. Body 3·5–4 ; tail 3·9–4·2 ; depth 11–15 ; eye 11–14 ; interorbit 2 ; eye twice into snout ; snout 8·5 ; gape 2·8. Dorsal about five times as high as anal fin, its origin in advance of gill opening. Lateral line absent. Length 847 mm.

Teeth. Ten marginals and three elongate mesial fangs are on the intermaxillary plate. There is a single row of smaller canines directed backwards on the maxillaries. Vomerines small and in a single row. The mandibulars consist of five large canines at the symphysis and a single row of smaller canines directed backwards. (Plate II, fig. r).

Distribution. Taken off Colombo. Found in coral reefs and shallow water.

Ceylon, Philippines, East Coast of Africa, Mauritius, South Coast of Arabia, East Indies, New Hebrides, Paumotus, Malay Archipelago, New Guinea, Singapore, Java, Samoa.

***Gymnothrax undulatus** var. **undulatus** (Lacépède) (Plate III, fig. 4. Plate II, fig. s).

Local name *Kabara galgulla—Blotched Muraena*
Divi galgulla—Leopard Muraena

A rather compressed muzzle merging into a round, full head. Three large pores along each maxillary. Body somewhat compressed, covered with thick skin. Lateral line absent. The nephridial tissue extends posterior to the cloaca terminating in a bulbous core deep in the tail muscles. These eels bite savagely when taken aboard and such is the power of their jaws that they break some of their teeth when they seize an iron bar or other hard object.

Colours. Handsomely coloured and, when alive, has a yellow mask which is only faintly marked with irregular russet brown blotches which arrange themselves on the body in more or less regular rows posteriorly and assume a somewhat polygonal shape. There appear to be three such rows and they combine with narrow yellow interspaces of body colour to impart a reticulate appearance.

Measurements. Body 2·7–3·2 ; tail 2·7–3·25 ; depth 10–12 ; eye 8–11 ; interorbit 1 ; eye 1·6–2 into snout ; snout 4·75–5·7 ; gape 2–2·5. Dorsal fin 2·5 times as high as anal fin and has thirty-seven large irregular russet brown blotches along its base. Length 870 mm.

Teeth. The intermaxillary plate has three long depressible mesial fangs and a single row of fourteen smaller canines on each maxillary, bordered by an inner row of 2 or 3 in young specimens. Vomerine teeth are in a single series 5–9 in number. The mandibulars are in a single series with a row of about eighteen teeth on each side. The symphysial teeth are long and fang-like. The two single rows of infrapharyngeal teeth form a V pointing anteriorly. (Plate II, fig. s).

Reproduction. Two gravid females were taken on hook and line in the Gulf of Mannar. Both specimens were captured in the same locality at different dates. Locality 8°·24· 5′ N. 79°· 41·5′ E, depth of sea 13·22 metres ; sea bottom consisted of paar ground with patches of living coral in the vicinity.

The first was taken at 7.30 p.m. March 20, 1926, and was preserved in 5% Formol. It was examined 20 months later. Entire length 783 mm., eye 10·5 in head, depth 9·75 in entire length. Diameter of ova 1·1 mm.

The second was taken at 8.30 p.m. February 11, 1927, and was preserved in 90% alcohol. It was examined 9 months later. Entire length 620 mm., eye 11, depth 12. Diameter of ova 0·82 mm.

Distribution. A very common eel inhabiting reefs and "paar" ground (*i.e.* submerged reefs, in deeper water). Has been taken while

trawling at a depth of 31–52 metres and appears to prefer bottom consisting of coarse grey or yellow sand, rock and paar ground. Pearl banks, Wadge bank, Pedro bank, Trincomalee.

Ceylon, Honolulu, Samoa, Molokai, Philippines, Malay Archipelago, Riu Kiu Islands, Andaman Islands, Coromandel Coast of India, Madagascar, Mauritius, East Coast of Africa, Australia, South Sea Islands, New Guinea, Formosa, China, Sandwich Islands, Red Sea.

***Gymnothorax undulatus** var. **fimbriatus** (Bennett) (Plate II).

Colour. (In life). Light greenish yellow, with numerous brown dots as large as the eye. Dorsal is three times as high as anal. Inside of mouth dark.

In old specimens the depth of body increases considerably and may be about ten into the entire length, whereas in ordinary specimens it is about 22.

A specimen 1,102 mm. long and 125 mm. in depth is in the Museum collection and has been preserved in formalin for many years. Colour is a pale slatey grey with black dots smaller than the eye.

Measurements. Body 3·5–4 ; tail 3·5 ; depth 9·5–22 ; eye 12–16 ; interorbit 1·4–2 ; eye 2 into snout ; snout 5–6 ; gape 2·5–3 ; length 650 mm. and over.

Teeth. Three intermaxillary mesial fangs and a single row of marginal teeth on intermaxillary plate and maxillaries. There are four teeth in a single row on the vomer. There is a single row of teeth on the mandibulars forming two rows near symphysis. (Plate II, fig. t).

Distribution. Wadge bank.

***Gymnothorax punctatus** Bl. Schn. (Plate IX, fig 2. Plate II, fig. u).

Anterior nares tubes, posterior nares holes in front and above orbit. Lateral line absent. Gill opening oblique, jaws equal and pointed. Fins on trunk and tail well developed. The flesh of this fish is considered poisonous, according to Day.

Colour. Purplish brown with white circular dots increasing in size posteriorly but which do not exceed the orbit in size.

Measurements. Body 3·4 ; tail 3·5–4 ; depth 11·5 ; eye 10–12 ; interorbit 1·5 ; eye 2 into snout. Snout 4·8, gape 1·9–2·1. Origin of dorsal fin in advance of gill cleft, in midvertex. Dorsal fin is four times as high as the anal fin. Length 870 mm.

Teeth. Three mesial intermaxillary fangs are surrounded by six large teeth in a single series. A single series of smaller teeth on maxillaries.

Four to nine vomerines in a single series. Mandibles have six large teeth at symphysis and a single row of 13 smaller teeth, while two double rows, each of eight infrapharyngeal teeth form a V which point anteriorly. (Plate II, fig. u).

Distribution. Pearl banks in Gulf of Mannar.

Ceylon, Coromandel Coast of India, found in reefs and shallow water.

* **Gymnothorax pictus** (Ahl.)

Dorsal fin 3 times as high as anal. Its origin well in front of gill opening. Snout compressed, rounded anteriorly. Eye over middle of gape. Jaws slightly overshot. Interorbital space convex. Tail thick anteriorly tapering posteriorly. Lateral line absent. Length 420 mm.

Colours. The ground colour is yellow with three longitudinal rows of brown stellate blotches on the body, which are somewhat larger than eye. There is a single row of blotches on dorsal. Interspaces scattered with numerous smaller spots.

Measurements. Body 2·9; tail 3; depth 12·5; eye 10; interorbit 1; eye 1·6 in snout. Snout 6; gape 2·5 in head.

Teeth. Teeth in a single series. Intermaxillary plate has 12 peripheral teeth around three mesial depressible fangs. Maxillary has 9 teeth. Mandibular 13 teeth. 6 teeth at mandibular symphysis. Vomerines 3.

Distribution. Pearl banks in the Gulf of Mannar. (A single specimen).

Ceylon, Malay Archipelago, Hawaiian Islands, Philippines, Riu Kiu Islands, East Africa to Natal, Madagascar, Australia, S. Arabia to W. Pacific Islands.

* **Gymnothorax afra** (Lacép.)[1]

Origin of dorsal at mid vertex, dorsal 3 times as high as anal. Gill opening oblique, snout compressed with strong, slightly undershot lower jaw. Eye in mid gape. Length 450 mm.

Colours. Yellow mask, light brown body with darker dorsal and anal. Eyes, corners of mouth and gill cleft surrounded by black.

Measurements. Body 3·5, tail 3·5, depth 10, eye 10, interorbit 1·5, eye 1·9 in snout, gape 2·25 in head.

Teeth. Intermaxillary has 3 mesial teeth. Maxillaries 16 in a single series. Mandibulars with an inner row of 2 teeth at symphysis. Vomerines none. Infrapharyngeals in two parallel double rows of 8.

Distribution. One specimen from Pedro Bank.

1. I have to thank Mr. J. Norman, of the British Museum, for this identification.

Ceylon, East Indies, Malay Archipelago, Australia, Tropical Atlantic.

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EXPLANATION OF PLATES

Plate I.

Fig. 1a. teeth pattern of upper jaw of *Synbranchus bengalensis* $\times 1\frac{3}{4}$.
Fig. 1b. teeth pattern of lower jaw of *Synbranchus bengalensis*.
Fig. 2a. teeth pattern of upper jaw of *Anguilla bicolor* $\times 1\frac{3}{4}$.
Fig. 2b. teeth pattern of lower jaw of *Anguilla bicolor*.
Fig. 3a. teeth pattern of upper jaw of *Anguilla elphinstonei* $\times 1$.
Fig. 3b. teeth pattern of lower jaw of *Anguilla elphinstonei*.

Plate II.

In each compartment, the upper jaw teeth pattern is on the left, the lower jaw on the right.

Teeth patterns of
a. *Muraenesox cinereus,*
b. *Leptocephalus cinereus*
c. *Ariosoma anago*
d. *Muraenichthys gymnopterus*

Teeth patterns of
e. *Sphagebranchus polyopthalmus*
f. *Sphagebranchus orientalis*
g. *Pisoodonophis cancrivorous*
h. *Ophichthus rutidodermatoides* (normal)
i. ,, ,, (old specimen)
k. *Leiuranus semicinctus*
l. *Moringua bicolor*
m. *Echidna zebra*
n. *Echidna nebulosa*
o. *Echidna delicatula*
p. *Strophidon brummeri*
q. *Uropterygius concolor*.
r. *Gymnothorax favagineus*
s. *Gymnothorax undulatus* var. *undulatus*
t. *Gymnothorax undulatus* var. *fimbriatus*
u. *Gymnothorax punctatus*.

Plate III.

Heads showing teeth patterns

Fig. 1.—*Muraenesox cinereus* $\times \frac{4}{5}$.
Fig. 2.—*Leptocephalus cinereus* $\times \frac{7}{8}$.
Fig. 3.—*Echidna zebra* $\times 1$.
Fig. 4.—*Gymnothorax undulatus* var *undulatus* $\times 1$.

Plate IV.

Synbranchus bengalensis $\times 1$.

Plate V.

Anguilla elphinstonei $\times \frac{1}{4}$.

Plate VI.

Anguilla bicolor $\times \frac{1}{3}$.

Plate VII.

Anguilla spengeli $\times \frac{1}{3}$.

Plate VIII.

Fig. 1.—*Muraenichthys gymnopterus* $\times 3\frac{3}{8}$.
Fig. 2.—*Moringua bicolor* $\times \frac{3}{8}$.

Plate IX.

Fig. 1.—*Sphagebranchus polyopthalmus* ×1.
Fig. 2.—*Gymnothorax punctatus* ×$\frac{3}{4}$.

Plate X.

Fig. 1.—*Echidna zebra* ×$\frac{1}{2}$.
Fig. 2.—*Echidna nebulosa* ×1.

Plate XI.

Fig. 1.—*Uropterygius concolor* ×$1\frac{2}{3}$.
Fig. 2.—*Echidna delicatula* ×1.

Plate XII.

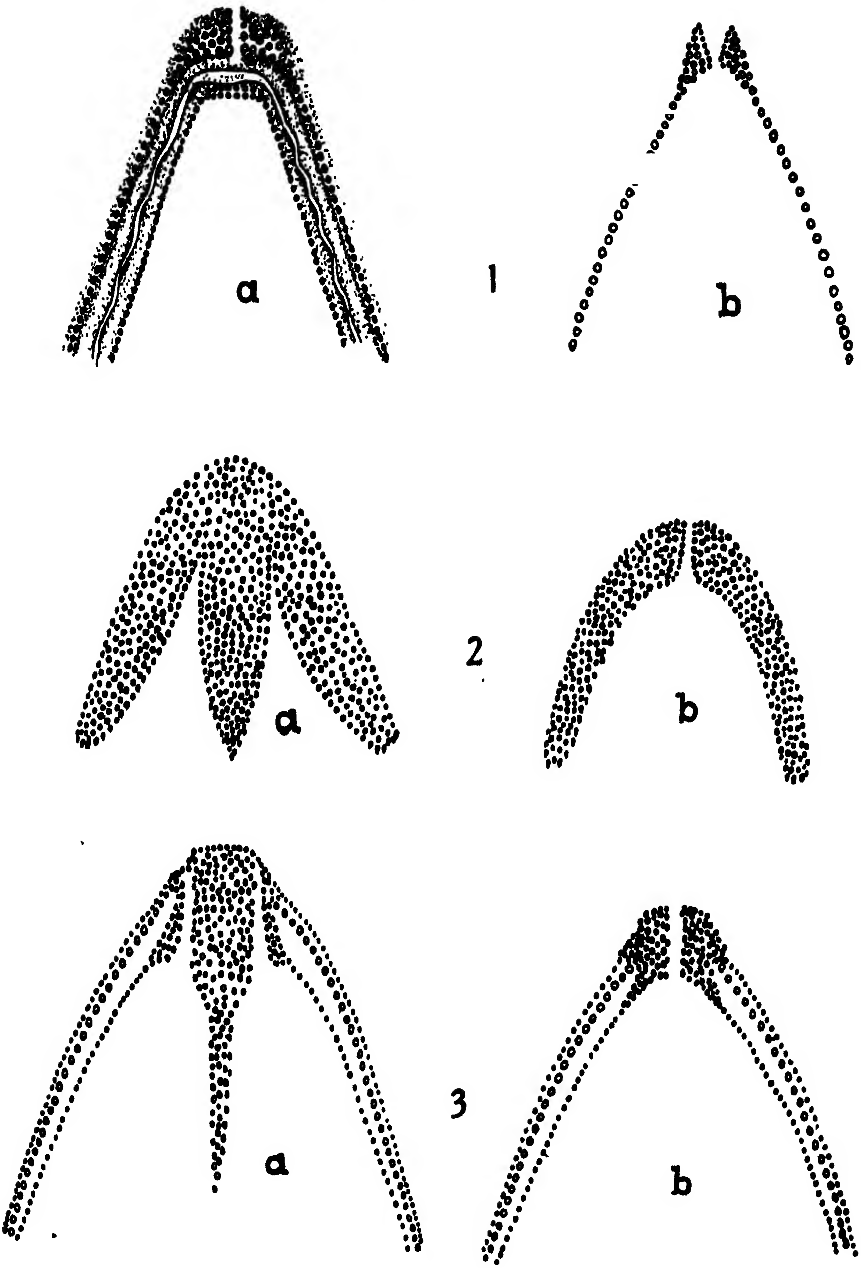
Brachysomophis cirrhochilus ×$\frac{1}{5}$.

ADDENDUM

On November 13, 1928, four unpigmented elvers of *Anguilla elphinstonei* and five level finned elvers were taken at surface between 9–11 p.m. on pearl banks. Locality Lat. 8°. 25·8′N. Long. 79°. 42·5′ E and 12·87 kilometres from mainland. Depth of sea 11·4 metres. Both types had gape ending under mid eye, while a single row of melanophores extended from the dark caudal fin half way or entirely along lateral line of tail. In *A. elphinstonei* pigment light and melanophores stellate, in the others melanophores contracted. Dimensions of elvers of *A. elphinstanei* as follows :—

Spec.	*Length*	*Head Length*	*Head and Trunk*	*D. ahead of A.*
1	56	6·2	21·5	6·5 mm.
2	55·5	6	20	6· mm.
3	55·4	6	21·5	6·8 mm.
4	55	6·1	21	5·9 mm.

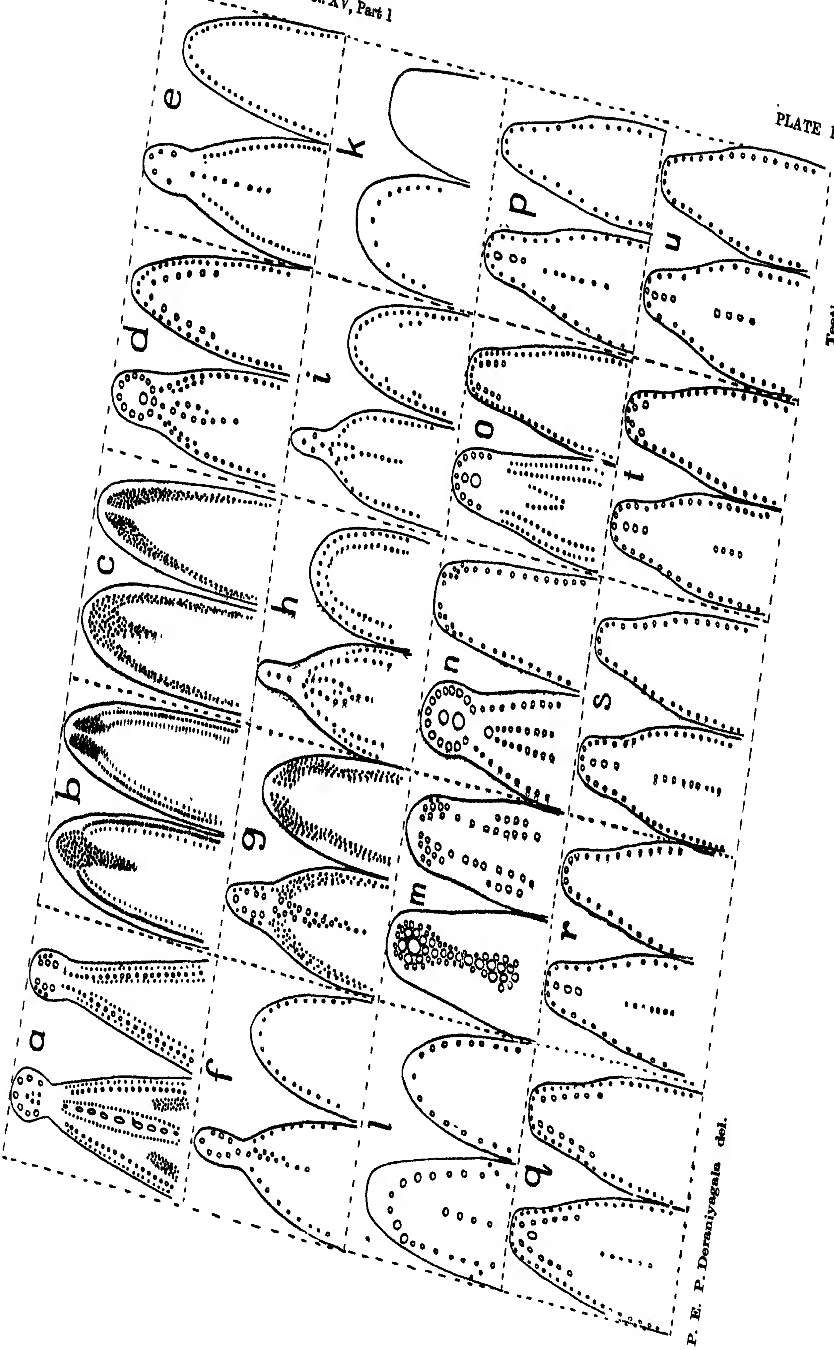
The level finned elvers were 52, 53, 53, 55 and 56 mm. in length.



P. E. P. Deraniyagala del.

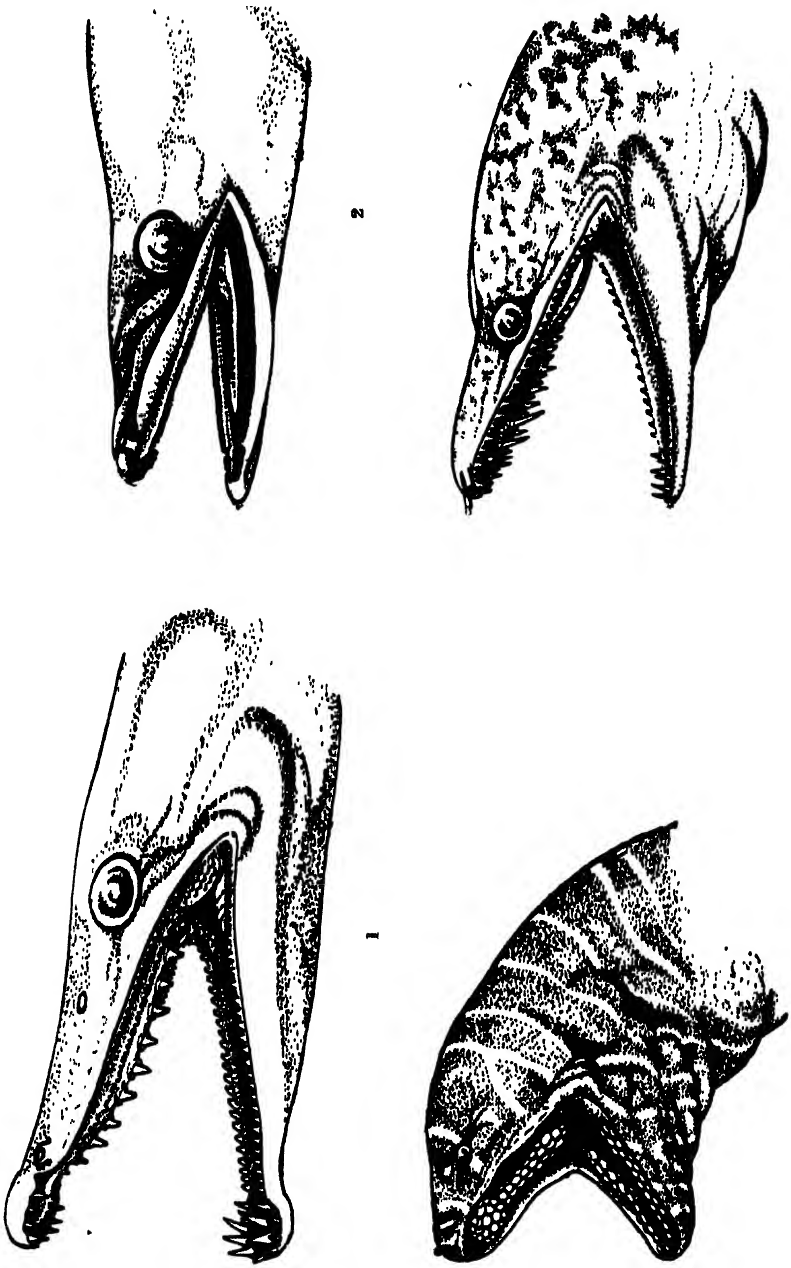
Teeth of *Synbranchus* and *Anguilla*

PLATE II



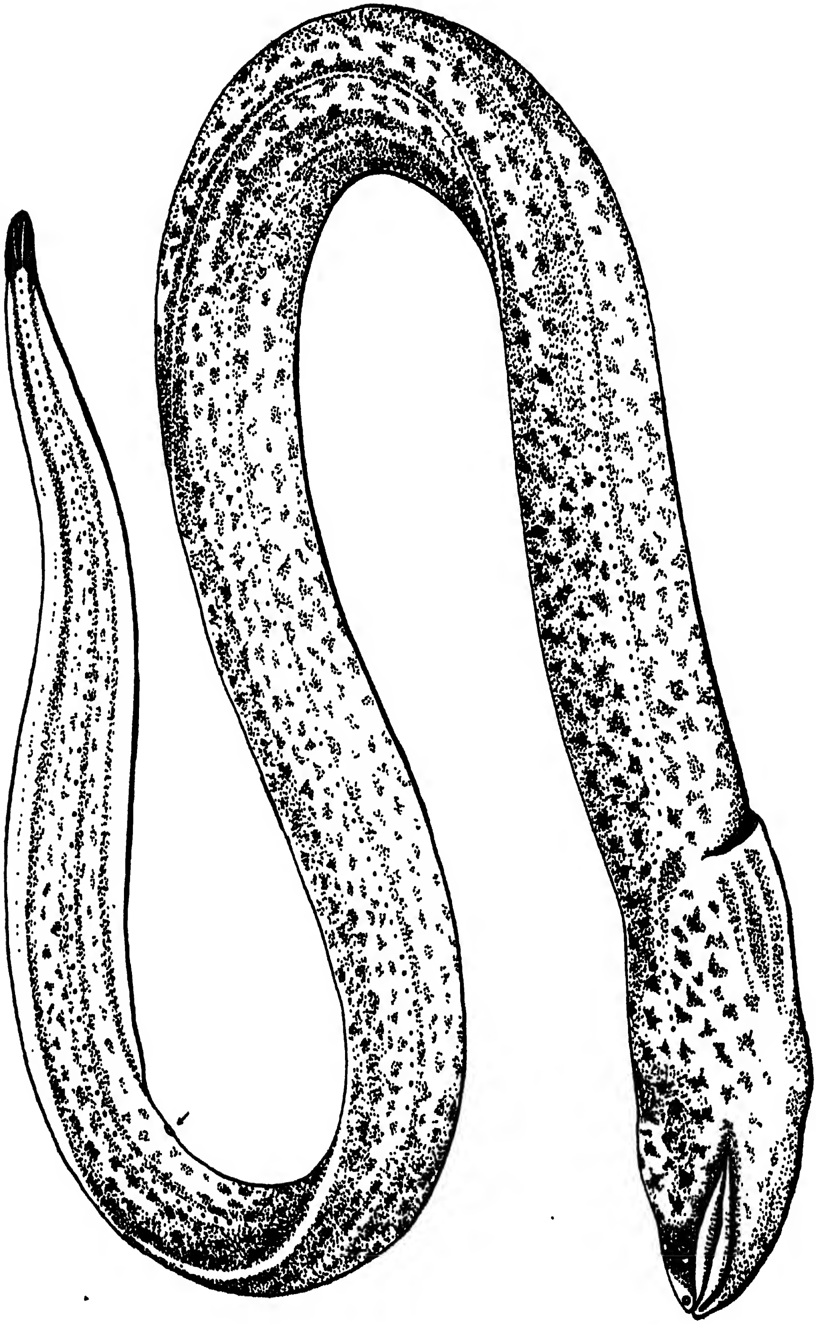
Teeth of Marine Anodes.

P. E. P. Deraniyagala del.



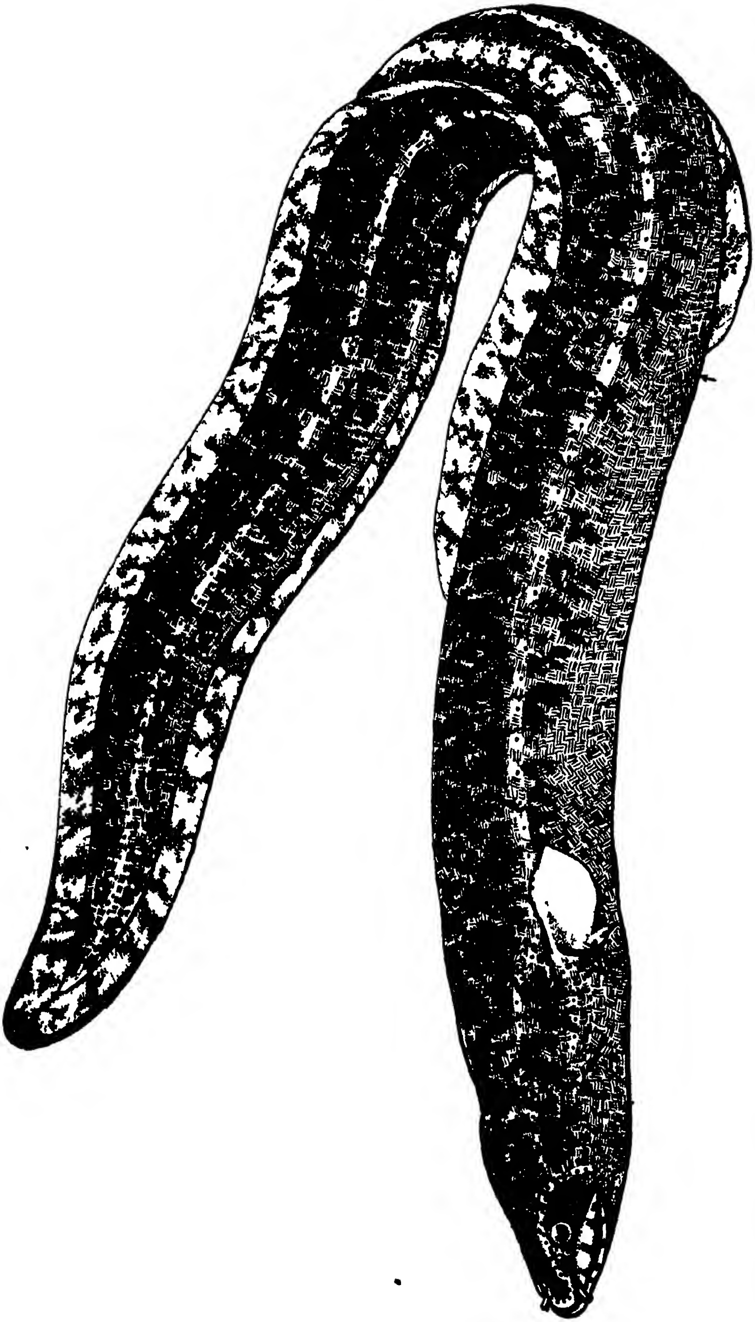
Heads of marine *Apodes.*

P. E. P. Deraniyagala del.



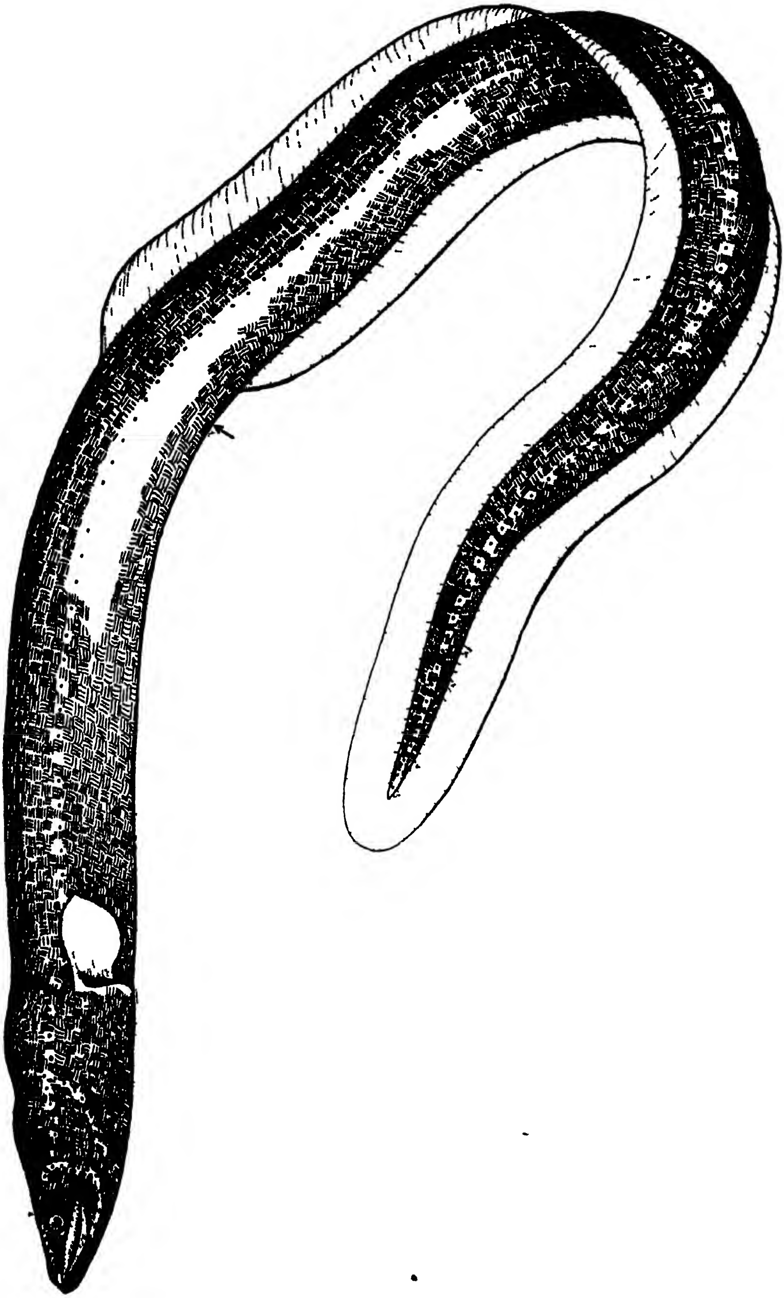
Synbranchus bengalensis (McClell.)

P. E. P. Deraniyagala del.



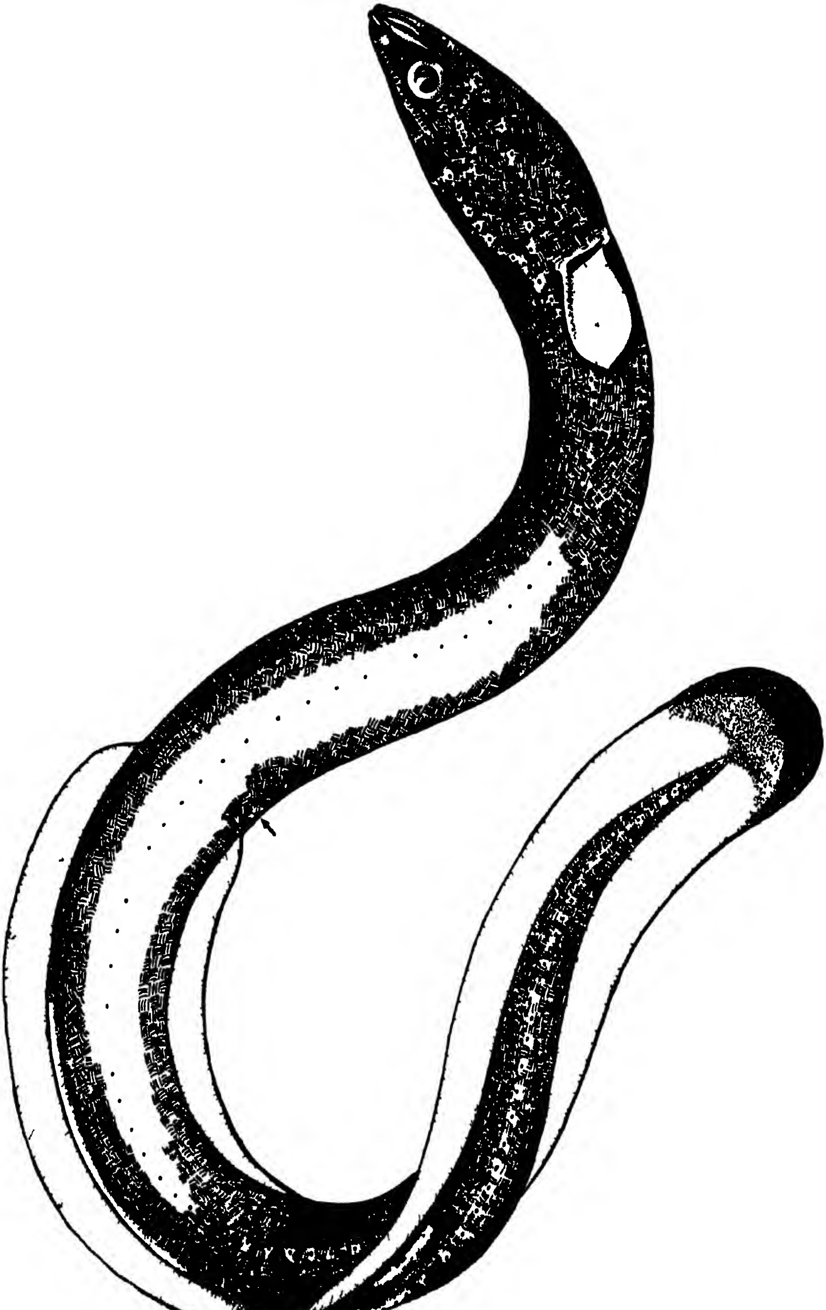
Anguilla elphinstonei Sykes.

P. E. P. Deran gala del.



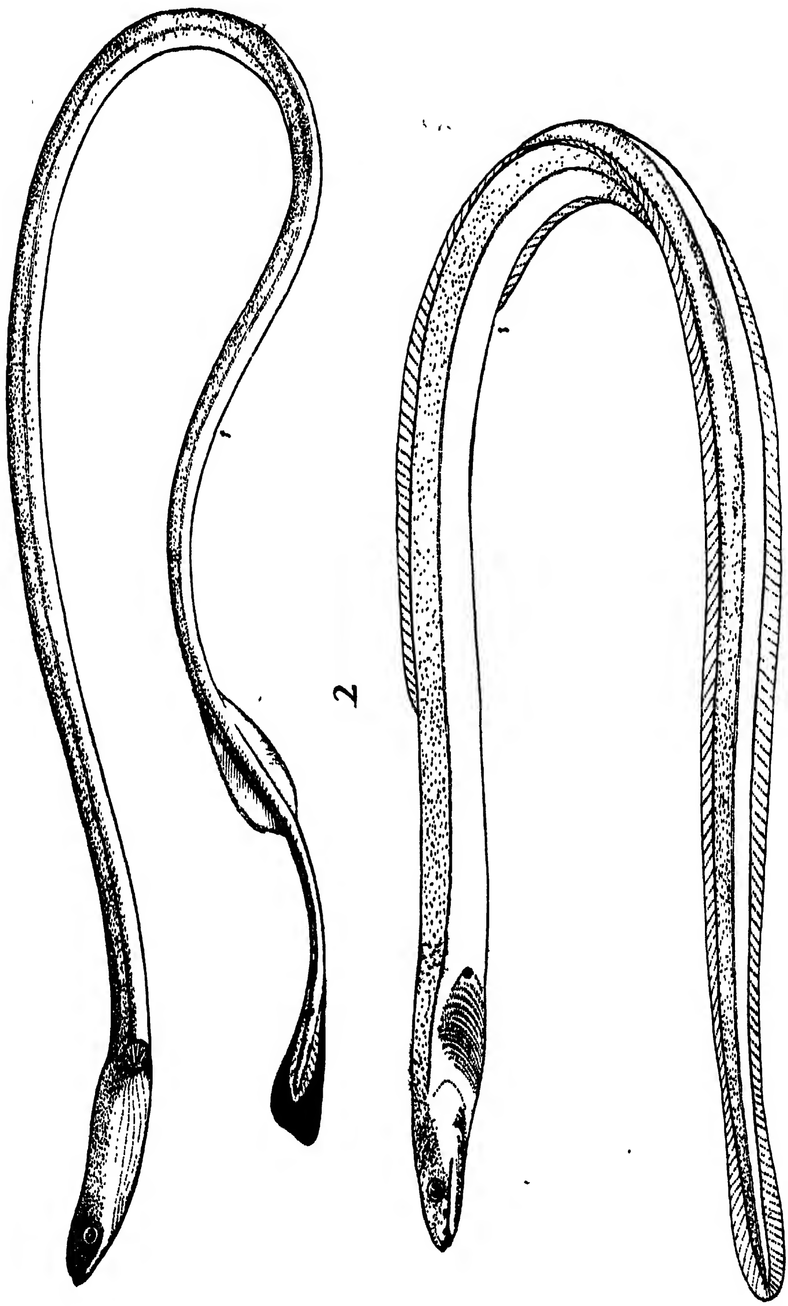
Anguilla bicolor McClell.

P. E. P. Deraniyagala del.



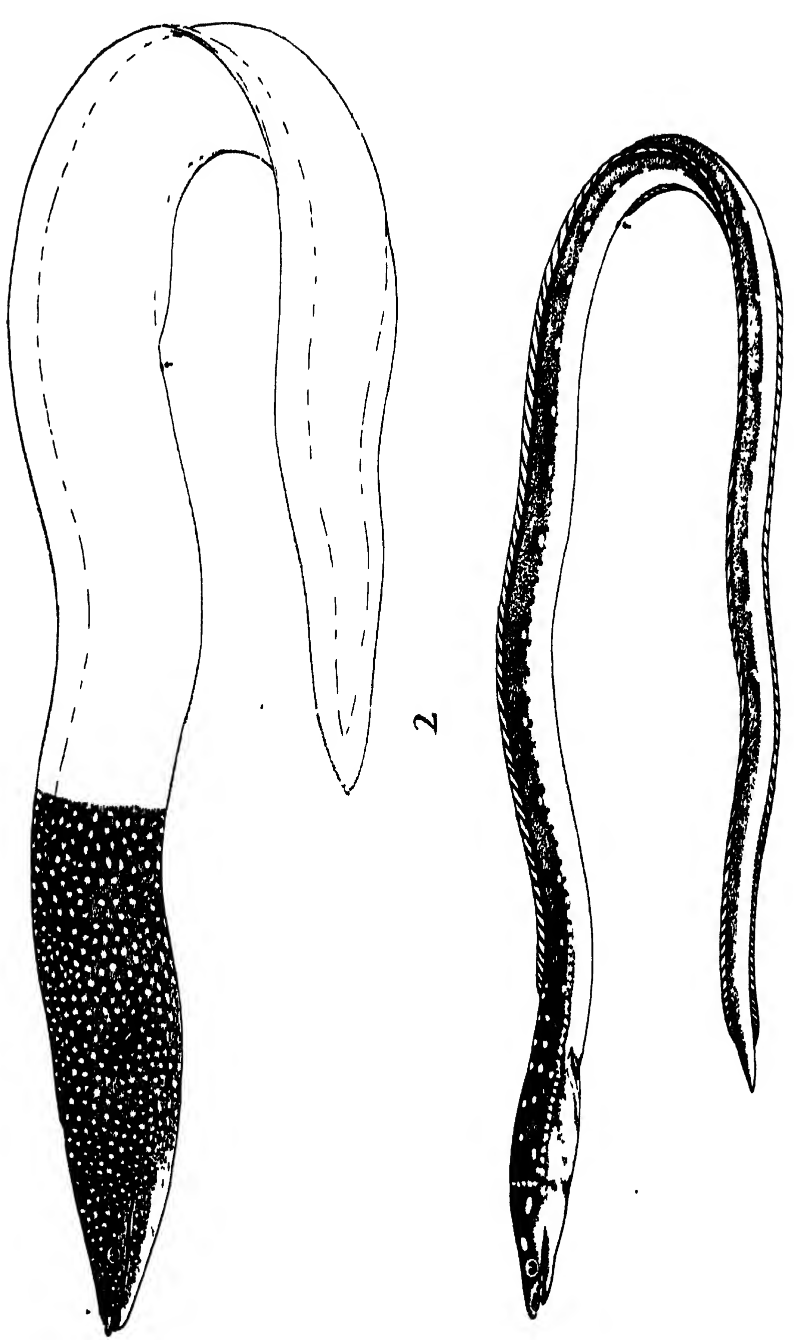
Anguilla spengeli Weber

P E P Deraniyagala del



2. *Moringua bicolor* Kaup.
1. *Muraenichthys gymnopterus* Blkr

P. E. P. Deraniyagala del.



2. *Gymnothorax punctatus* Bl. et. Schn.
1 *Sphagebranchus polyopthalmus* (Blkr.)

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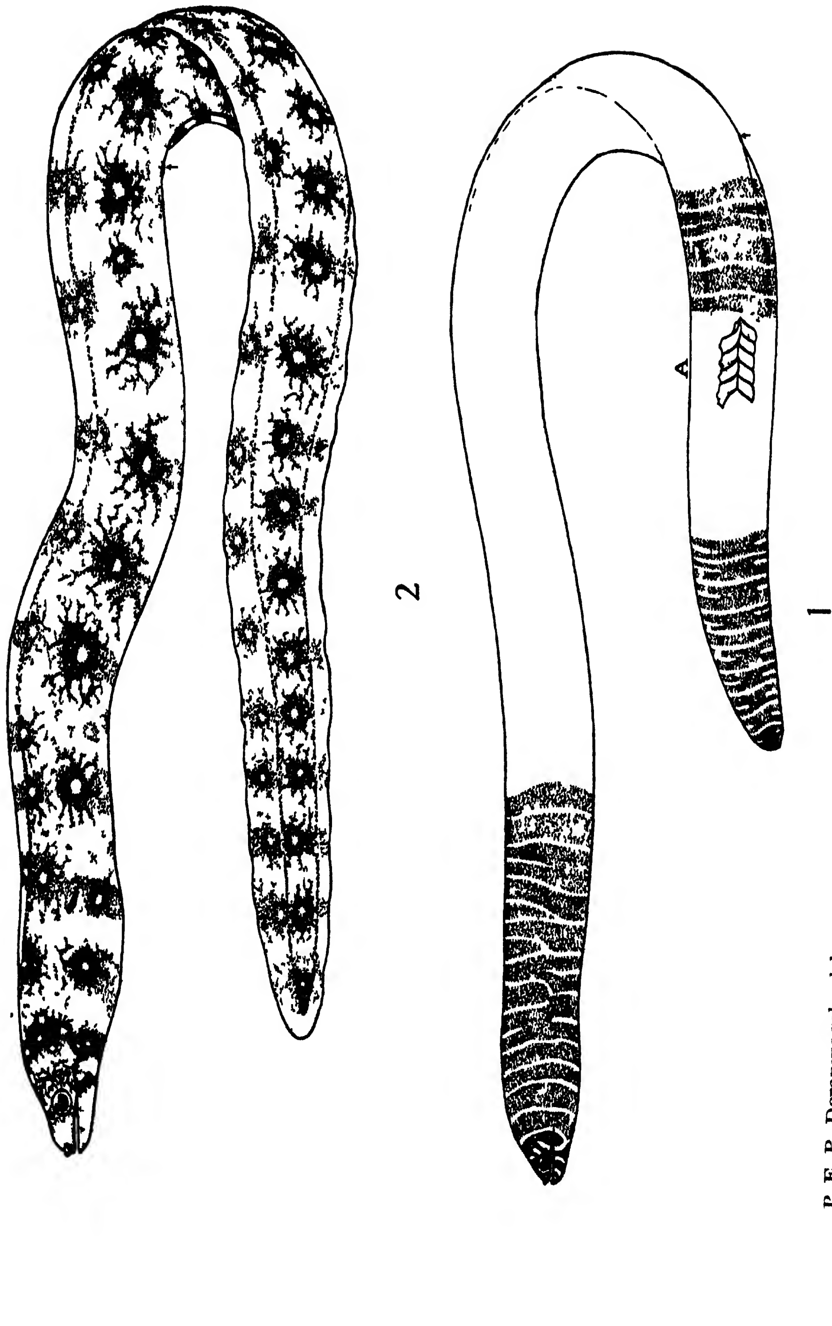
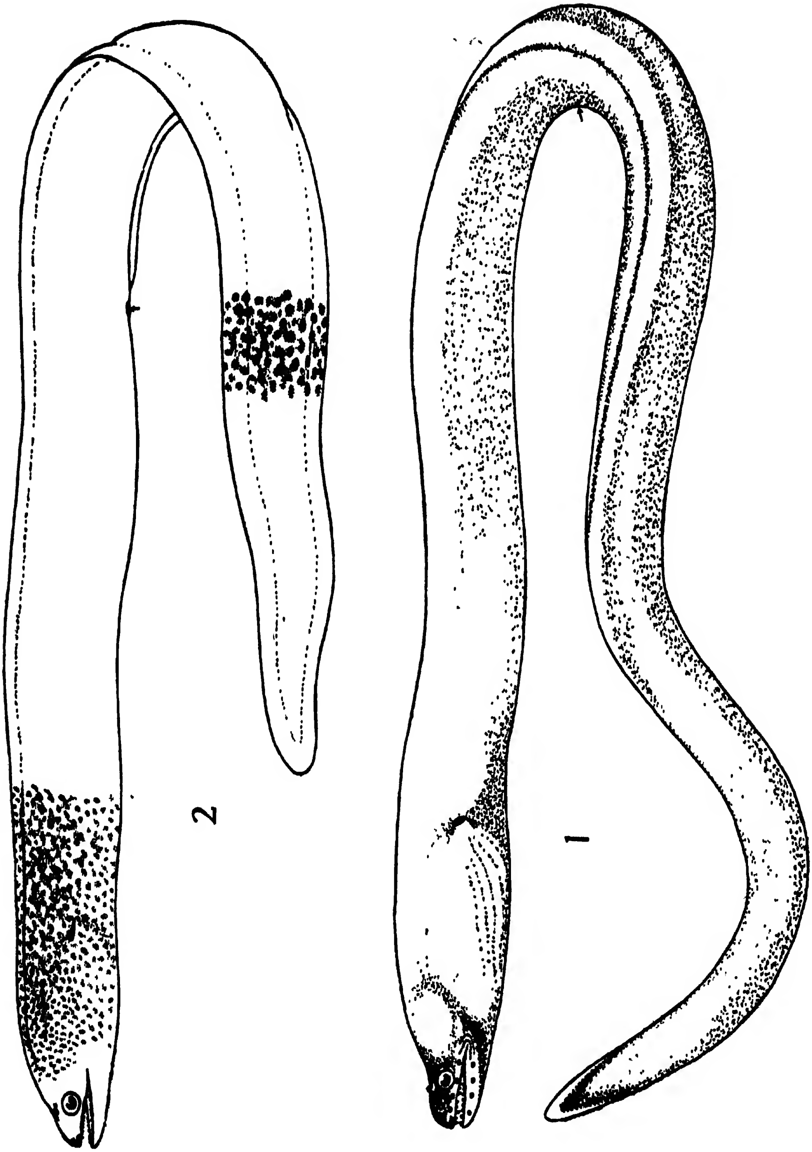
PLATE X



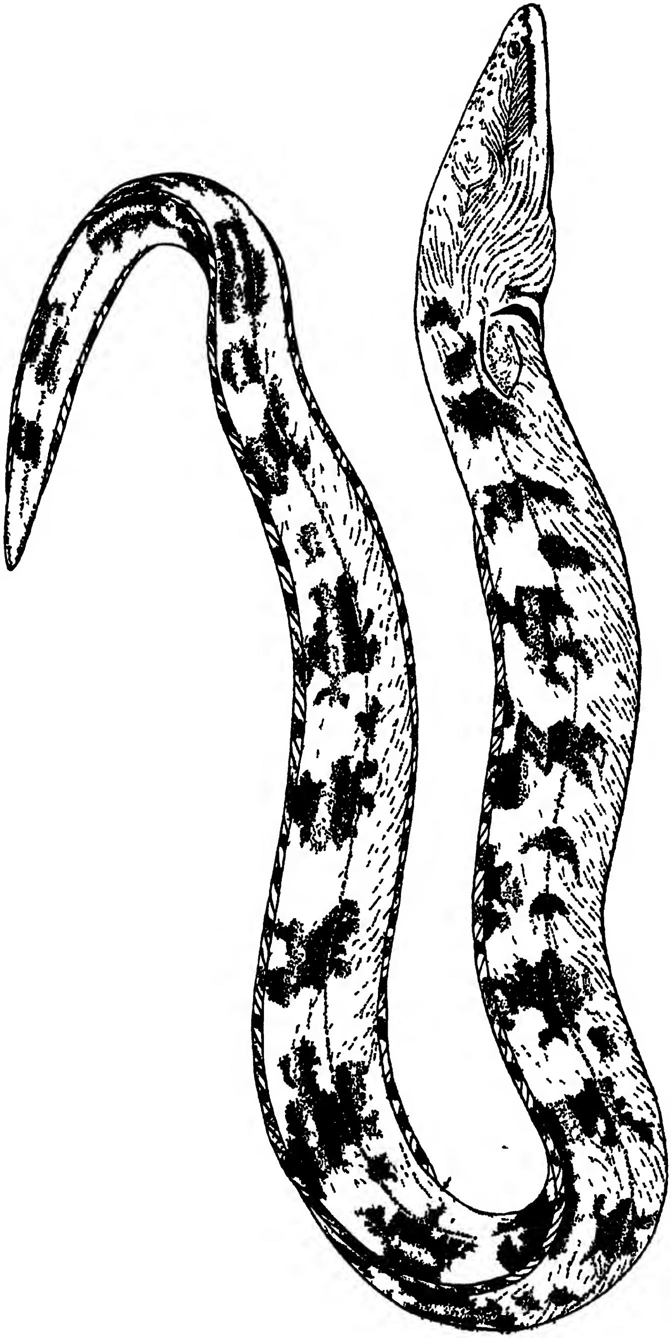
2 *Echidna nebulosa* (Ahl)
1 *Echidna zebra* (Shaw)

P E P. Deraniyagala del



2. *Echidna delicatula* (Kaup)
1. *Uropterygius concolor* Rüppell

P. E. P. Deraniyagala del.



Brachysomophis (Brachysomophis) cirrhochilus (Blkr.)

P. E P Deraniyagala del.

Ceylon Sardines

BY

P. E. P. Deraniyagala, M.A. (Cantab), A.M. (Harvard)

2nd Assistant Marine Biologist, Fisheries Department

WITH SIX PLATES

This paper deals with Clupeoids collected by the Fisheries Department from Ceylon waters. The family Engraulidae and the genus Pellona are not included. Fishes not previously reported from Ceylon are denoted by an asterisk against their names. For a complete list of synonyms see Weber and Beaufort "Fishes of the Indo-Australian Archipelago," Vol. II, 1913.

Sub-order CLUPEOIDEA

Oblong fishes; abdomen generally compressed with a serrated ventral edge. Scales cycloid, thin, often with the hinder portion fenestrate, pectinate and crenulate. No scales on head. No lateral line. Adipose eye lid present or rarely absent. Dentition feeble or absent. Upper jaw has large lateral maxillaries which carry supplemental bones. Gill membranes free. Ventral fins small or absent.

Key to Ceylon Families

A. Abdominal edge without scutes.
- (*a*) Belly carinate, teeth long ....*Chirocentridae.*
- (*b*) Belly rounded, teeth short.
  - (a[1]) Maxillary with 2 supplemental bones ....*Dussumieriidae.*
  - (b[1]) Maxillary with 1 supplemental bone .... *Ehiravidae.*

B. Abdominal edge with scutes.
- (*a*) Maxillary composed of 3 bones ....*Clupeidae.*

(*b*) Maxillary composed of 2 bones
Jaws edentulous
Gizzard present .... *Dorosomidae.*

Family **Chirocentridae**

Compressed, elongate fishes. Mouth large. Maxillary long, narrow, with 2 supplemental bones. Scales small, deciduous. No pseudobranchiae. Branchiostegals 8. Only a single genus known (*Chirocentrus*).

Chirocentrus dorab (Forsk.) (Plate XIII).

Local names.	*Sinhalese*	*Tamil*
	Podi katuvalla	*Thuppu valla*
	Pannu kattuvalla	*Mullu valla*
	Gal kattuvalla	*Kuru valla*
	Path kattuvalla	*Kallaku valla*

Four forms are recognised by Sinhalese and Tamil fishermen, but these appear to be the same fish at different stages of growth.

D 14–17. P 13. V 7. A 33. B 8.

Head 4·75–5·6, eye 5–6, depth 6–6·8[1].

Gill rakers 15 flat, rounded with one side pectinate; longest equal to half length of branchial filaments. Preorbital bone large, overlaps posterior edge of maxillary bone. Anterior edge of preorbital curved, posterior edge abruptly truncate and is slightly anterior to tip of maxillary. Maxillary 1·8, long, narrow with two supplemental bones, of which the anterior is the larger. Termination of maxillary pointed, its anterior margin serrate carrying about 34 teeth which reduce to about 7 with age.

Teeth consist of 4 strong close-set canines at incisure of upper jaw, covered by a fleshy fold when mouth closed. Mandibles with about 7 curved, strong canines. Fine, close–set, granular teeth on infrapharyngeals, vomers and palatines. Adipose eye lid complete and well developed. Sub–orbitals and preopercle heavily veined.

Distance from base of dorsal fin to base of caudal 3·1 to 3·5 times into distance from dorsal to snout tip. Base of dorsal 2 to 2·5 into base of anal. Origins of dorsal and anal nearly level.

1. "Length" is from tip of snout to base of caudal fin, "Head" $= \frac{\text{length}}{\text{head}}$, "Depth" $= \frac{\text{length}}{\text{depth}}$, "eye," "maxillary bone" and "snout" are expressed as fractions of "Head." "Interorbit" $= \frac{\text{interorbit}}{\text{eye}}$. "Gill rakers" are those on lower limb of first branchial arch, measurements made from tip of snout to base of caudal fin.

Pectoral fin equals head minus snout ; has a large pointed internal and a shorter rounded external axillary scale. Upper ray of pectoral well developed, flattened, unbranched. Ventral fin very small, shorter than its axillary scale. Fish elongate, compressed, with numerous small deciduous cycloid scales. Ventral keel sharp but without serrature. No abdominal filaments as shown by Day in "Fishes of India." The ends of ribs frequently work their way through the body wall in dead specimens giving the appearance of filaments ; hence the error. Length 1000 mm.

Colours. (In life). Top of head and back is greenish yellow with light red reflections. Upper tip of lower jaw green. Fins hyaline or pale yellow. Outer ray of pectoral black, dorsal dusted with black, caudal with a dark edge.

(After death). Top of head and back bright emerald green, beneath which area is a broad band of sea blue. Below this is a narrow lateral stripe of reddish yellow which is followed by a broad expanse of silver on the sides and belly. It is interesting to note that no blue is visible in life and after death the green is intensified but rapidly disappears.

Distribution. This fish is caught throughout the year, especially from November to January and in June and July along the West Coast by seines, drift nets and hook and line. The bait employed is shrimps and small fish.

Although well flavoured it is inferior as food being full of minute bones which have earned for it, its Sinhalese and Tamil names, which signify "Mass of Bones." It is in considerable demand amongst the poorer classes and is also used as bait for Istiophorus.

Ceylon, India, China, Siam, Malay Archipelago, Japan, New Guinea, Queensland, Formosa, Red Sea and Natal.

Family **Dussumieriidae**

No abdominal scutes. Anal fin small and set far back. Pseudobranchiae present. Jaws nearly equal. Adipose eyelids wide, thin.

Maxillary has 2 supplemental bones and is rounded posteriorly.

Dussumieria acuta Cuv. et Val. (Plate XVIII)

Local names. *Thondaya* (*S*)[1]
Thondai, (*T*)

D 18–20. P 14–17. V 8. A 15–18. B 15–18. LL 42–46. L tr. 12. Head 3·7–4, eye 3–3·8, depth 4·5.

1. (S.) signifies, Sinhalese, (T) Tamil.

Gill rakers 20–23, spinous inner edge and equal in length to half orbit.

Maxillary 3 or less into head, small, does not reach eye level. Jaws nearly level and pointed. Postfrontal striae absent. Preopercle has a sharp posterior angle. Subopercle is rhombic. Suborbital veined. Teeth on mandibulars and maxillaries sharp and close set in a single row. The mandibular teeth are larger. Origin of dorsal fin considerably nearer base of caudal than to snout tip. Distance from dorsal to caudal nearly twice distance from dorsal to snout tip. Base of dorsal slightly longer than base of anal. Insertion of ventrals about level with middle of dorsal. Pectorals as long as snout and three-quarters of eye. Caudal fin is 4·5 into the length.

Shape elongate, belly rounded and smooth, profile from snout to forehead straight. Scales[1] very deciduous, entire, faintly pectinate and crenulate. (Plate XVIII, fig. 2). Length 134 mm.

Colours. Bluish green dorsally with a golden lateral stripe separating the back from the sides and abdomen which are silvery.

Distribution. The shoals appear in June and November and are captured in seine nets (Ma–del) and (Nool–del).

The fish is sold fresh or "Jadied," *i.e.*, brine cured.

Collected at

Mavella,	July,	1926.
Panadura,	November,	1926.
Negombo,	November,	1926.
Udappua,	November,	1926.
Pesalai,	June,	1927.

Ceylon, India, Penang, Singapore, Malay Archipelago, Philippines, China, South Arabia.

A new genus and species[2]

EHIRAVA gen. nov.

Rounded, elongate with conical head. Jaws slightly undershot, maxillary free with a single supplemental bone. Adipose eyelids thin but well developed. Origin of dorsal behind insertion of ventrals and in mid-back or somewhat closer to caudal than to tip of snout. Scales

1. Scales are "Crenulate" if posterior half has longitudinal lines, "fenestrate" if pierced with holes, , "entire" if not pierced, "pectinate" if hind edge be broken into serrations, "regular" if not so broken up.

2. The genus *Ehirava* is created to receive a form which is intermediate between *Spratelloides* Bleeker and *Dussumieria* Cuv. et Val. The fish was first noted in 1926 and later sent to the British Museum for confirmation of the writer's opinion that it was entitled to rank as a separate genus. Mr. J. R. Norman very kindly compared it with known species in the collection and concurred with the writer. He says it is closely allied to *Spratelloides malabaricus* Day which also has only one supplemental bone. Day's description and figure do not mention or show the presence of adipose eye lids. The generic name is derived from the Sinhalese name of the fish.

moderate, very deciduous. Branchiostegals six. Gill rakers flat 25–27. Pseudobranchiae developed.

***Ehirava fluviatilis** spec. nov. (Plate XIV)

Local names. *Ehirava*, (*S.*)
Gan ehirava, (*S.*)—*River ehirava*

Fins. P 12–14. V. 8. D 13. A 15. C 19.

Scales. Cycloid entire with 3 or 4 straight radii extending inwards from margin for some distance. LL. 35–38, L tr. 6–7, predorsals 15. preventrals 17.

Measurements. Head 3·6–4·25, eye 3, depth 4·8–5, pectoral 6, ventral 6·9–7, caudal 4–4·2 into entire length (without caudal fin). Maxillary 2·75 into head, reaches front of orbit and has serrate lower edge. Carries a single supplemental bone which reaches to tip of maxillary. Adipose eye lid thin, but well developed in adult. Hind margin of preopercle nearly straight. Well defined venation on preopercle and opercle. Gill rakers 25–27, flat, slender, tuberculate, slightly longer than branchial filaments.

Belly rounded, smooth. Origin of dorsal in mid-back or slightly closer to caudal than to snout, its base equidistant from base of caudal and hind edge of orbit ; its height nearly equal to head length. Pectoral as long as eye and snout together, its tip far from ventrals which are inserted anterior to origin of dorsal and midway between pectoral and anal. Caudal deeply emarginate with two rather enlarged scales at base. Length of fish 50 mm.

Colours. Vertex green with about six large melanophores arranged in a ring in interorbital space, followed by a V-shaped pattern on parietals with the apex directed posteriorly. Body an iridescent, pearly pink.

Distribution. In rivers and estuaries up to 15 miles from the sea, large shoals of half grown specimens appear in May and December and are captured in a fine net termed "Saluva" which is dragged along the sand. The fish is sold fresh and is a delicacy.

Piliandera, Kalutara S., Panadura, Digela, Kehelvatta, Kelaniya, (Western Province).

Ceylon.

Type. 50 mm. long, head 4 into length. Sent to the British Museum.

Family **Clupeidae**

Oblong fishes, ventrally compressed, belly keeled with scutes along the edge, snout never overshot. Teeth small or absent. Pseudobranchiae present. Scales thin, pectinate. Gill rakers slender.

Maxillary with two supplemental bones. Adipose eyelids present or absent.

Key to Genera

A. Anal and ventral fins moderate, adipose eyelids present.
   (*a*) Insertion of ventrals before origin of dorsal ....*Clupeoides*.
   (*b*) Insertion of ventrals after origin of dorsal ....*Clupea*.

B. Anal long, ventrals absent, no adipose eyelids ....*Opisthopterus*.

Clupeoides lile (Cuv. et Val.) (Plate XVIII)

Local names. *Silinda, (S.)—Colombo*
Sudhu sudaya, (S.)—Negombo— White sardine
Vella chudai, (T.)—White sardine

D 13–15. P 13. V 8. A 18. B 6. LL 35. L tr. 8–10.
Head 3·75–4·2, eye 2·7, depth 2·8–3·25.

Gill rakers 32–34, equal to half orbit and slightly longer than branchial filaments. Teeth on tongue and palate.

Maxillary 2·2 reaches up to front half of orbit. Eye equals post-orbital part of head, jaws slightly undershot. 10 postfrontal striae. Sub-opercle nearly rectangular, slanting upward posteriorly with a rounded edge. Origin of dorsal nearer to tip of snout than to base of caudal.

Insertion of ventrals anterior to origin of dorsal and midway between pectorals and anal.

A compressed fish with upper profile nearly straight, lower profile from symphysis to ventral fin is strongly concave. Scales rather large, entire, regular with one or two unbroken transverse lines. (Plate XVIII, fig. 3).

18 prominent preventral scutes, 10 postventrals. Length 65 mm.

Colours. Head silvery with greenish yellow vertex. Body white and translucent. Two rows of melanophores along back and base of anal. Caudal fin has a dark edge and darker tips. Fins hyaline. A silver lateral streak extends from head to tail.

Distribution. This fish is in considerable demand as a broth for convalescents and possesses a faint chalky flavour. It is not obtainable from February till May, but appears in June and is taken in the finer meshed drag nets such as Pala-del, Kudu-del and in seines such as Ma-del and Nool–del.

Specimens were taken from

Batticaloa, August, 1922.
Negombo, June, November, 1926.

Ceylon, India (West Coast), Siam, Burma, Penang, Java, Batavia.

Genus **Clupea** Linn.

Key to Sub-genera

A. Belly rounded, scutes small and flat,
no postventral serrature .... *Amblygaster.*

B. Belly compressed.
(*a*) Scutes large, intermaxillaries
meet at an acute angle. .... *Alosa.*
(*b*) Scutes medium, intermaxil-
laries meet at an obtuse angle .... *Harengus.*

Clupea (Amblygaster) leiogaster (Cuv. et Val.) (Plates XV and XVIII)

Local names *Hurulla,* (*S.*)
Kirimin chalai, (*T.*)

D 15–18. P 16. V 8. A 18–20. B 6. LL 45. L tr. 11.

Head 4, eye 3–3·8, interorbit 1, depth 4·5–4·75.

Gill rakers 30–40, tuberculate, shorter than branchial filaments and are 0·6 of orbit. Teeth on tongue and palate.

Maxillary 2–3 barely reaches orbit. 9–12 postfrontal striae. Hind margin of preopercle rounded. Opercle more than 2 as high as broad. Eye 1·2 into snout. Dorsal midway between snout tip and base of caudal; its base shorter than that of anal. Pectoral equals head without snout.

Base of dorsal goes 1·5 into base of anal. Caudal 4·5 into total length.

Shape round, elongate. Scales entire with faintly pectinate and crenulate hind margins and have about 5 transverse lines broken in the centre. (Plate XVIII, fig. 4).

16 predorsal scales, 16–17 preventrals, 13 postventrals. Length 200 mm.

Colours. Dark greenish blue dorsally separated from silvery sides by a longitudinal pearly band which carried 12–18 dark blue spots.

Distribution. Appears in large shoals from September till January in the deeper bays and further out to sea than most Ceylon Clupeiids which usually prefer shallow water near the coast. This fish is netted in purse seines, Elana-del and seine nets Ma-del and Nool-del and is abundant at Weligama, S.P., and at Trincomalee (E.P.), where cart loads were taken daily during the first half of October, 1928, whilst on October 15th, 1928, the shallow waters of the bay swarmed with transparent Clupeoid larvae which probably belonged to this species. It is

a well flavoured fish and in considerable demand by all classes. The surplus fish is "Jadied" at the various curing stations established by the fishermen. It is also used as live bait for *Istiophorus*, *Xiphias*, *Thunnus*, etc., and is carried in large wicker work baskets attached to the sides of outrigger canoes.

The stomach contents of *C.* (*A*) *leiogaster* usually consist of Copepods. The fish has been collected from Tangalla, Deundara, Kudavella in September, 1926, Koralavella November, 1922, Karativu October, 1926, Negombo December, 1927, Trincomalee October, 1928. Colombo markets, November–March.

Ceylon, India, Singapore, Java, Sumatra, Celebes, China, Red Sea.

*Clupea (Amblygaster) clupeoides (Blkr.) (Plate XVIII)

Local name. *Gal hurulla* (*S*).—*Rock hurulla*

D 17–19. P 15–17. V 8. A 16–17. B 6. LL 40–43. L tr. 11–12. Head 4–4·2, eye 3–3·5, depth 3·75–4.

Gill rakers 27–29. Coarsely tuberculate, about 2/3 length of branchial filaments or ½ orbit.

Maxillary 2·9–3, does not quite reach front of eye.

Teeth on palatines, pterygoids, tongue.

Origin of dorsal in midback or somewhat closer to tip of snout than to caudal.

Base of dorsal much nearer to caudal than to tip of snout and somewhat longer than base of anal and equal to length of pectoral. Pectoral equals eye and snout together, ventral midway between insertion of pectoral and origin of anal. Caudal is 4 into length.

Shape, elongate and rounded with a sharper nose than *C. leiogaster*.

Scales faintly crenulate, entire, with about 3 vertical lines broken, in the centre. (Plate XVIII, fig. 5). 15 predorsal scales, 16 preventrals 12–14 postventrals. Length 188 mm. and over.

Colours. Blue green dorsally with silver sides, fins pale greenish yellow.

Distribution. Appears in Colombo markets from November till March, is caught in seine nets.

"Jadied" or sold fresh.

Specimens examined 27. 2. 27 had ¾ ripe ova.

Ceylon, Singapore, Java, Celebes, Ambon, Philippines, Samoa, Red Sea, Mozambique, Zanzibar.

*Clupea (Alosa) toli Cuv. et Val.

Local names. *Ulla, (S.)—Colombo*
Ullam, (T.)

D 18. P 14. V 8. A 20. B 6. LL 40. L tr. 14.

Head 4, eye 5, depth 3.

Gill rakers 103 smooth, longer than orbit.

Maxillary 2·15 reaches slightly beyond hind edge of eye, posterior supplemental bone reaches hind edge of maxillary. Teeth and post-frontal striae absent. Angle of preopercle rounded, width of opercle is 1·75 into its height. Venation on cheeks, opercle and shoulder. Origin of dorsal closer to snout tip than to caudal fin by postorbital length of head. Base of dorsal equal to that of anal, placed in a scaly sheath in midback. Height of dorsal equal to postorbital part of head. Pectoral with well developed axillary scale, shorter than head by half snout, does not reach ventrals. Ventral fin has a long axillary scale, located under middle of dorsal and is equidistant from snout tip and caudal. Caudal fin is 3 into length, covered with small scales.

The fish is oblong, almost equally convex dorsally as ventrally. Ventral scutes present.

Scales sparsely fenestrate, deeply pectinate with 13–16 unbroken vertical lines. Predorsal scales 16, postdorsals 20, preventrals 16. postventrals 13, length 310 mm.

Colours. Purplish green dorsally, six longitudinal rows of small diffuse brown scale marks, silvery sides. Fins yellow, caudal has a dark diffuse edge. Young have a dark shoulder mark.

Distribution. Pesalai.

Ceylon, India, Malay Archipelago, Malay Peninsula, Siam, Formosa.

Clupea (Alosa) kanagurta (Blkr.) (Plate XVIII)

Local names. *Seriya, Koiya, (S.)*
Kattu Massa, (S.)—Bone fish
Koii Meen, (T.)

D 15–16. P 14–15. V 7–8. A 19–21. B 6. LL 44. L tr. 14.

Head 3·6, eye 4, interorbit 1, depth 2·6.

Gill rakers 125–151 have a serrated edge and are equal to orbit or 2 length of branchial filaments.

Maxillary 2, reaches hind half of orbit. Teeth, a few on mandibular symphysis and vomers. 6 diverging postfrontal striae ; heavy venation on preopercle and top of opercle.

Origin of dorsal fin closer to snout than to caudal fin by a snout length. Base of dorsal slightly nearer to caudal than to snout. Base

of dorsal equals base of anal, equals post orbital part of head. Pectoral equals head without opercle and does not reach the ventrals which have their insertion under the first third of dorsal. Caudal fin has inferior lobe rather longer than superior one, its length equal to or less than head length.

Shape, oblong, compressed, with a large head and somewhat wide gape. Scales strong, fenestrate, faintly crenulate, pectinate with the vertical lines overlapping in the centre. (Plate XVIII, fig. 6).

Predorsal scales 15, preventrals 15, postventrals 13 mm. Length 190 mm.

Colours. Body light yellow dorsally merging into silver on sides and abdomen with a black shoulder mark often followed by three or four similar blotches especially in immature specimens. Dorsal fin yellow with a black tip; caudal yellow with a dark inner margin.

Distribution. This species is not partial to sheltered water as are most Clupeoidea and is taken along the unsheltered shore in seine nets and appears in numbers in May and October.

Collected at

Batticaloa,	August,	1922.
Kankesanturai,	October,	1925.
Udappua,	November,	1926.
Mannar,	May,	1927.

Ceylon, India, Java, Sumatra, Aden, Zanzibar.

Clupea (Harengus) brachysoma (Blkr.) (Plate XVIII)

Local names. *Sudaya, (S.)—Colombo*
Karalau, (S.)—Matara
Chudai, (T.)

D 18. P 15–16. V 8. A 18–20. B 6. LL 40–45. L tr. 11–13. Head 4, eye 3 ,depth 2·6.

Gill rakers 110–121 are ⅔ of orbit in length.

Maxillary 2·1 reaches mid eye. Teeth on tongue, palatines, pterygoids, 10 slightly converging postfrontal striae. Width of opercle goes 2·5 into its height. Venation on upper part of suborbital, preopercle and opercle. Origin of dorsal fin nearer to tip of snout than to caudal. Base of dorsal slightly nearer to caudal than to snout and equal to anal. Last dorsal ray somewhat strong. Pectoral equals head without half the snout. Caudal 3·5, very scaly.

Shape, oblong, rather more convex ventrally than dorsally.

Scales fenestrate with holes of varying size, deeply pectinate, about 7 vertical lines broken in centre. (Plate XVIII, fig. 7).

Predorsal scales 14–15, preventrals 18, postventrals 14. Length 135 mm.

Colours. Pale purplish green dorsally, silvery sides, a dark patch at base of first three dorsal rays. Numbers are taken in seine nets and sold " Jadied " or fresh.

Distribution. Specimens collected from

Batticaloa,	August,	1922.
Matara,	November,	1926.
Panadura,	November,	1926.
Kalutara,	November,	1926.
Mannar,	November,	1927.
Colombo fish markets,	February,	1927.

Ceylon, India, Java, Sumatra, Borneo, Australia, China.

Clupea (Harengus) fimbriata (Cuv. et Val.) (Plate XVIII)

Local names. *Gal Salaya, (S.)—Rock Salaya*
Chalai, (T.)

D 17–20. P 15–16. V 7–9. A 16–19. B 6. LL 42–45. L tr. 10–12. Head 3·6–4, eye 3–4, depth 4–4·5.

Gill rakers 50–70 almost equal to branchial filaments. Maxillary 2·5–3 reaches front 1/3 of eye. Teeth on tongue and mandibles, 8–14 converging postfrontal striae. Hind margin of opercle nearly straight, with a straight lower edge. Suborbital, preopercle and opercle heavily veined. Head somewhat rectangular, nearly as deep as body.

Dorsal fin in mid back with its base in a high scaly sheath. Base of anal equal to or rather longer than base of dorsal. Caudal fin scaly and equal to head length.

Pectoral equals head without snout. Ventrals inserted under anterior third of dorsal and are in mid belly.

Shape, elongate, compressed ventrally, slightly concave profile behind eyes, followed by a convex profile. Ventral profile mildly convex. Scales are usually fenestrated with holes of various sizes, but in some parts of the body may be entire. Deeply pectinate, fenestrate and crenulate with about 8 vertical lines interrupted in the centre. (Plate XVIII. fig. 8).

Predorsal scales 15, preventrals 18–19. Postventrals 14–15. Length 140 mm.

Colours. Dark bluish green dorsally with a yellow lateral stripe silver sides, pale green fins, dark blotch at origin of dorsal fin covering base of first five dorsal rays.

Distribution. Caught in cast nets and seines and "jadied" or sold fresh. The " Kahava billiya" or triple hook is also employed for the

capture of this fish. The hook is flung into a shoal and jerked out sharply thereby often transfixing three fish. Is said to appear in enormous shoals off Mullaitivu from February till October, when the daily catch is as much as 100 cwt.

The immature fish is elongate but increases in depth with age till it bears a close resemblance to *Clupea brachysoma.* The chief nets employed in its capture are the Chalai vallai, Vella vallai, and Tholi vallai.

Specimens were collected at

Thannan Kuda,	August,	1922.
Kankesanturai,	October,	1925.
Matara,	November,	1925.
Panadura,	December,	1925.
Moratuwa,	June,	1926.
Colombo Market,	May,	1927.

Ceylon, India, Java, Sumatra, Malay Archipelago, Australia, Tonga Islands, Fiji Islands, Philippines, Malacca, China, South Arabia, Zanzibar.

Clupea (Harengus) atricauda Gthr. (Plate XVIII)

Local names. *Salaya, (S.)*
Chalai (T.)

D 16. P 15. V 8. A 20. B 6. LL 43. L tr. 12.

Head 4, eye 3, depth 3·5.

(From a single specimen in Formol). Gill rakers 58 smooth, somewhat longer than branchial filaments.

Maxillary 2·5, reaches anterior edge of eye. Teeth on palate.

6 converging postfrontal striae.

Snout equals eye. Subopercle rhomboid, width of opercle is 2·5 into its height. Venation on suborbital.

Base of dorsal fin nearer to caudal than to snout tip by $\frac{3}{4}$ snout. Base of dorsal slightly shorter than base of anal.

Insertion of ventral slightly closer to pectoral than to anal, and under interior third of dorsal. Pectoral equals head without snout.

Shape, sub-oblong, compressed ventrally.

Scales rather large, entire, faintly pectinate with 6 vertical lines anterrupted in the centre. (Plate XVIII, fig. 9).

13 predorsal scales, 17 preventrals, 11 postventrals. Length 100 mm.

Colours. Tips of lobes of caudal, deep black. Fins hyaline, dorsal aspect darker than sides and belly.

Distribution. Ceylon, India, Malay Archipelago, Samoa, Society Islands, Andamans, Madagascar,

Clupea (Harengus) moluccensis (Blkr.) (Plates XVI and XVIII)

Local names. *Kolamurru Salaya*, (*S.*) *Colombo*
(Adults) *Korrumburrua*, (*S.*) *Galle.*
(Young) *Ehelamurrua*, (*S.*) *Galle.*

D 17–18. P 15–16. V 8. A 17–19. B 6. LL 41–45. L tr. 10–11.

Head 3·5–4, eye 3, depth 3–3·8.

Gill rakers 30–34, longer than branchial filaments and equal to half orbit.

Maxillary 2, reaches mid orbit. 3 or 4 parallel postfrontal striae.

Subopercle rhombic with heavy venation on suborbitals, preopercles, opercles and continued on to some of the dorsal scales. Teeth on tongue and palatines, four at tip of each mandibular.

Base of dorsal fin nearer to caudal than to tip of snout by one orbit. Origin of dorsal nearer to snout tip than to caudal.

Base of anal shorter than that of dorsal. Pectoral equals head without snout. Caudal 3·7–4 into length.

Shape, elongate, ventrally compressed, but body depth does not exceed depth of head to any extent.

Scales entire, crenulate with about five continuous vertical lines unbroken in centre, which are characteristic. A few scales, however, do have the vertical lines interrupted in the middle. (Plate XVIII, fig. 10).

12 predorsal scales, 17 preventrals, 12–13 postventrals. Length 122 mm.

Colours. Dorsal aspect dark green separated from the silver sides and abdomen by a yellow lateral stripe. There are two bright orange spots immediately behind the gill cleft. Top of snout brown, tip of dorsal fin brownish yellow, pectorals, ventrals and anal hyaline.

Distribution. Appears in large swarms during April and May and are either netted in seines such as Nool-del, Ma-del and Kara-del or taken on the bare hook or the "Kahava billiya" or three-pronged hook. At Galle large shoals form dark patches in the water sheltered by the coral reef and consist of adults and immature specimens from 57–77 mm. long. Netting the fish is prohibited, so the unbaited hook on a horse hair line is employed. The hook is barbless and constructed by passing a brass point through a small silver cone and bending it back. The line is fastened on to notches cut in the shank of the hook. At Talpe-pattu, Ahangama and Hambantota the net "Korrumburu dela" is named after this fish which constitutes the chief catch. Although well flavoured, the flesh of *C. moluccensis* at Galle is reputed to be toxic during certain seasons, hence it is not a popular item of diet.

Distribution. Has been collected from Galle, during May and November, 1926, and May, 1927. Jaffna and Trincomalee May, 1927.

Ceylon, Singapore, Malay Archipelago, Nicobars, Andamans, Fiji Isles, New Hebrides, Solomon Isles, China, Japan.

Clupea (Harengus) longiceps (Cuv. et Val.) (Plate XVIII)

Local names. *Pesalaya, (S.)*
Pechalai, (T.)

D 16–17. P 15–16. V 8–9. A 14–15. B 6. LL 46. L tr. 11–14.

Head 3–3·6, eye 4–4·5, interorbit 0·9, depth 4–4·5.

Gill rakers 165–206 slightly longer than eye. Posterior supplemental bone reaches end of mouth.

Maxillary 2·5–2·75 reaches mid eye. Eye goes 1·5 into snout. 8–14 diverging postfrontal striae. Teeth on palatines, pterygoids and tongue. Subopercle rectangular and narrower than opercle. Opercle twice as high as broad. Venation on suborbitals, preopercle and top of opercle.

Base of dorsal nearer to caudal than to snout tip and slightly longer than base of anal. Origin of dorsal in scaly sheath and is nearer to snout tip than to caudal. Origin of ventral closer to caudal than to snout tip.

Pectoral equals postorbital part of head, origin has a large external scale as well as an internal axillary scale.

Last anal ray well developed. Caudal 4·75 into length.

Shape, elongate, compressed ventrally, body depth about the same as that of head.

Scales crenulate, with 3 or 4 vertical lines interrupted in the centre ; about 4 horizontal lines extend to posterior crenulate portion of scale, (Plate XVIII, fig. 11).

16 predorsal scales, 18 preventrals, 13 postventrals. Length 150 mm.

Colour. (In Formol). Silvery sides and belly, darker above (fresh dead specimen), lighter in colour than *C.(H.) fimbriata,* yellowish patch on shoulder behind opercle, back greenish yellow with a light yellow lateral stripe between back and silvery sides. Dorsal fin yellow, pectorals and ventrals hyaline, caudal dusted with black.

Distribution. Taken in "Kara vela" at Lunava in large numbers 6.12.22 ; Negombo 3.12.27. Gives its name to the town of Pesalai where it is said to occur in large shoals.

Ceylon, India, Java,

Opisthopterus macrognathus Blkr. (Plates XVII and XVIII)

Local name. *Thottava, (S.)*

D 16–17. P 13. V 0. A 58–60. B 6. LL 46. L tr. 13.

Head 4·75, eye 3, depth 3·25.

Gill rakers 27–30. Coarse, spinulous and somewhat longer than branchial filaments. Teeth on jaws, tongue and palate.

Maxillary 1·9–2, has a denticulate ventral border, slants upwards. Two ridges on each side of head which converge posteriorly, then unite to form a single ridge which diverges from the united single ridge of the opposite side. Preopercle forms a very obtuse angle posteriorly. Dorsal fin located above middle of anal. Distance from dorsal to base of caudal goes twice into distance from dorsal to tip of snout. Base of anal is in a scaly sheath. Pectoral longer than head and goes 1·9 to 2 into anal which it just fails to reach.

Shape, highly compressed with a very convex profile from mandibular symphysis to anal fin. Dorsal profile of head concave with the vertex convex.

Scales elliptical, smooth, rather deciduous with lines running in from the margin. (Plate XVIII, fig. 12).

30–33 sharp abdominal scutes. Length 178 mm. and over.

Colours. (Fresh dead specimen). Dark patch on top corner of opercle, vertex green. Dorsal aspect greenish brown, sides silver.

Caudal and dorsal fins yellowish, anal and pectorals hyaline.

Distribution. Taken in seine nets during July and November.

Collected from

Udappua,	November,	1926.
Negombo,	November,	1926.
Galle,	November,	1926.
Matara,	November,	1926.

Raconda Gray, the allied form, has not been obtained.

Ceylon, India, Singapore, Borneo, Java, Sumatra.

Family **Dorosomidae**

Body short, deep, compressed, adipose eye lids developed, mouth slightly overshot, bordered by premaxillaries, maxillary with one supplemental bone. Pseudobranchiae large.

Dorosoma nasus (Bloch.) (Plate XVIII)

Local names. *Suthara Koiya, (S.)—Filamented Koiya*
Koii meen, (T.)

D 15. P 16. V 8. A 22. B 5. LL 46. L tr. 19.

Head 4, eye 3·5, interorbit 1, depth 2·7.

Gill rakers 226–240. Fine and equal to ¼ orbit or 2/3 branchial filaments.

The small maxillary reaches anterior edge of orbit and is equal to one orbit in length. Snout shorter than orbit.

8 converging postfrontal striae. Suborbital and preopercle are veined.

Base of dorsal nearer to caudal than to tip of snout and is opposite ventrals. Origin of dorsal nearer to snout tip than to caudal. Last dorsal ray, thickened, and filamentous and in the adult reaches the base of caudal fin ; in young specimens under 80 mm. it reaches half way between the dorsal and caudal fins.

Pectoral equals head. Anal goes 4·75 into length, has a long base.

Adults compressed, deep with strong, sharp, ventral scutes. Length 220 mm. and over. The young are elongate and resemble *Clupea fimbriata* in outline.

Mouth small and overshot, teeth absent.

Scales strong, elliptical, entire, pectinate and crenulate, with each pectination having a bifid apex. (Plate XVIII, fig. 1).

Predorsal scales 20, preventrals 17, postventrals 11.

Colours. Silvery body with yellow fins. Occasionally a diffuse pink lateral band. Seven longitudinal rows of grey dots above lateral line. A black shoulder spot usually present.

Distribution. Taken in sheltered bays and lagoons and being mud eaters these fishes have developed a gizzard. Specimens have been taken from the Pearl Banks, Puttalam Lagoon, Kalpitiya, Lake Tamblegam, Hambantota, the South Coast lagoons, and are caught in seines and drag nets such as Pala-del and Adina-del. Abundant in Colombo markets throughout June and July.

D. indicus (Russel) which has no filamentous dorsal ray, has not been obtained by the Ceylon Fisheries Department.

Ceylon, India, Singapore, Java, Celebes, Philippines, China, Formosa, New Guinea, Australia, South Arabia, Sokotra.

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EXPLANATION OF PLATES

Plate XIII

Chirocentrus dorab $\times \frac{1}{5}$.

Plate XIV

Ehirava fluviatilis $\times 3\frac{1}{4}$.

Plate XV

Clupea (Amblygaster) leiogaster $\times \frac{4}{5}$.

Plate XVI

Clupea (Harengus) moluccensis $\times 1\frac{1}{5}$.

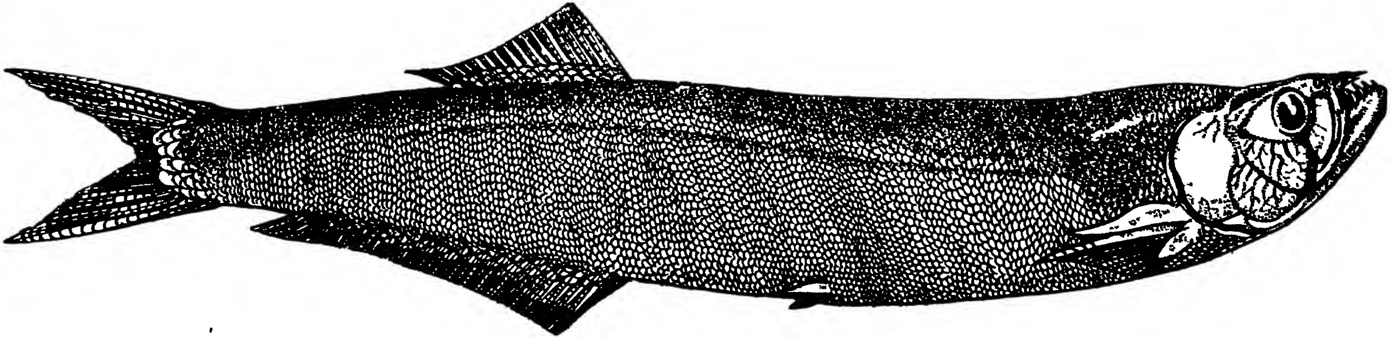
Plate XVII

Opisthopterus macrognathus $\times 1$.

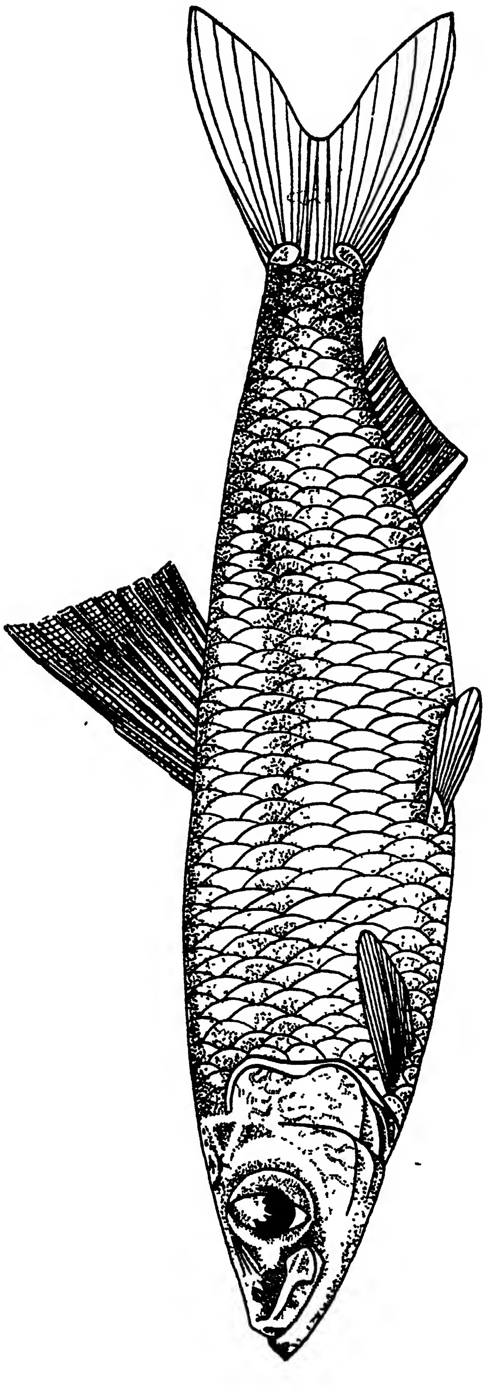
Plate XVIII

Scales of Clupeoids

Fig. 1. *Dorosoma nasus*
Fig. 2. *Dussumieria acuta*
Fig. 3. *Clupeoides lile*
Fig. 4. *Clupea (Amblygaster) leiogaster*
Fig. 5. *Clupea (Amblygaster) clupeoides*
Fig. 6. *Clupea (Alosa) kanagurta*
Fig. 7. *Clupea (Harengus) brachysoma*
Fig. 8. *Clupea (Harengus) fimbriata*
Fig. 9. *Clupea (Harengus) atricauda*
Fig. 10. *Clupea (Harengus) moluccensis*
Fig. 11. *Clupea (Harengus) longiceps*
Fig. 12. *Opisthopterus macrognathus*

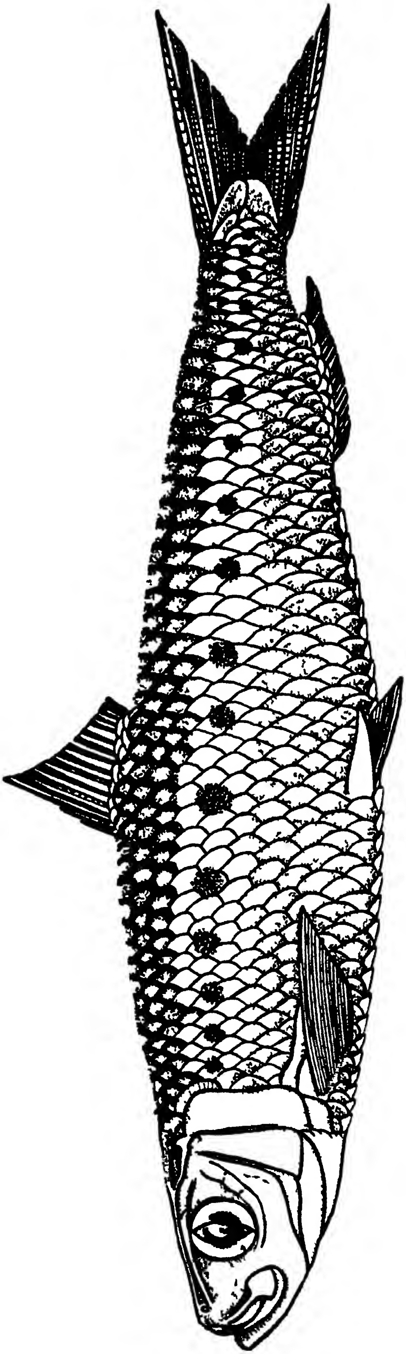


P. E. P. Deraniyagala del. *Chirocentrus dorab* (Forsk).



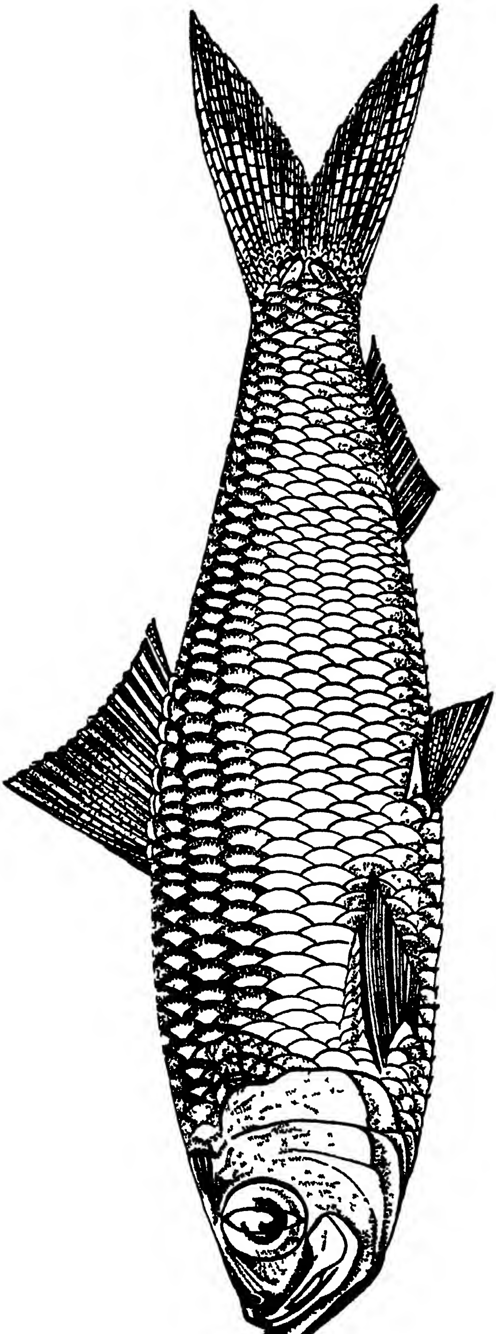
Ehirava fluviatilis Deraniyagala

P. E. P. Deraniyagala del.



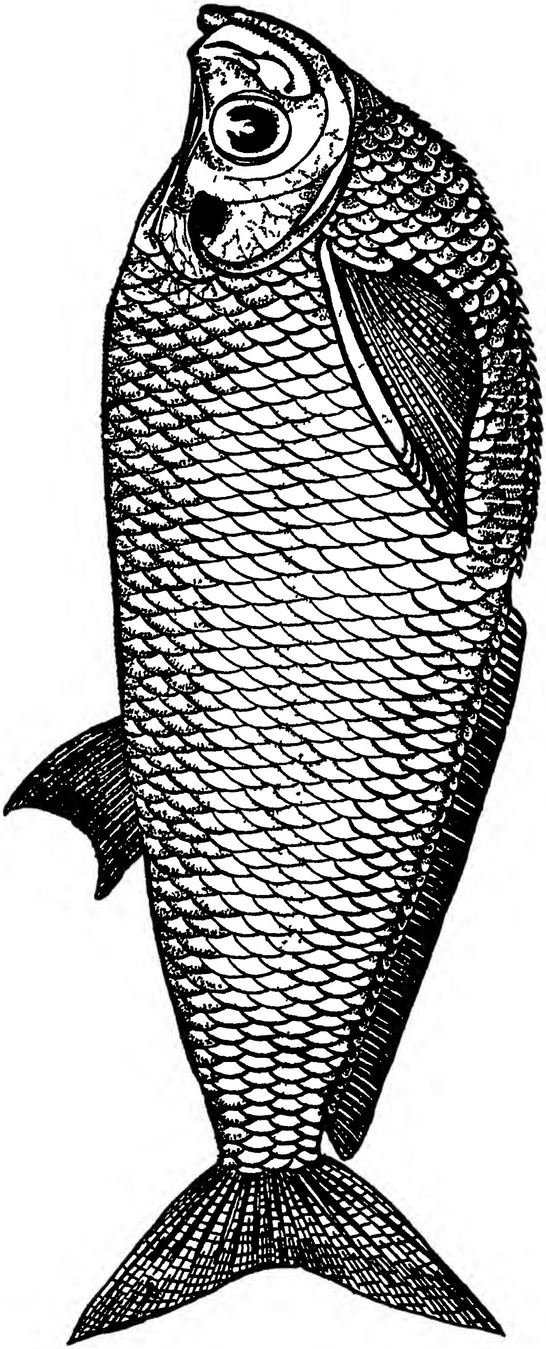
Clupea (*Amblygaster*) *leiogaster* (Cuv et Val)

P E. P. Deraniyagala del



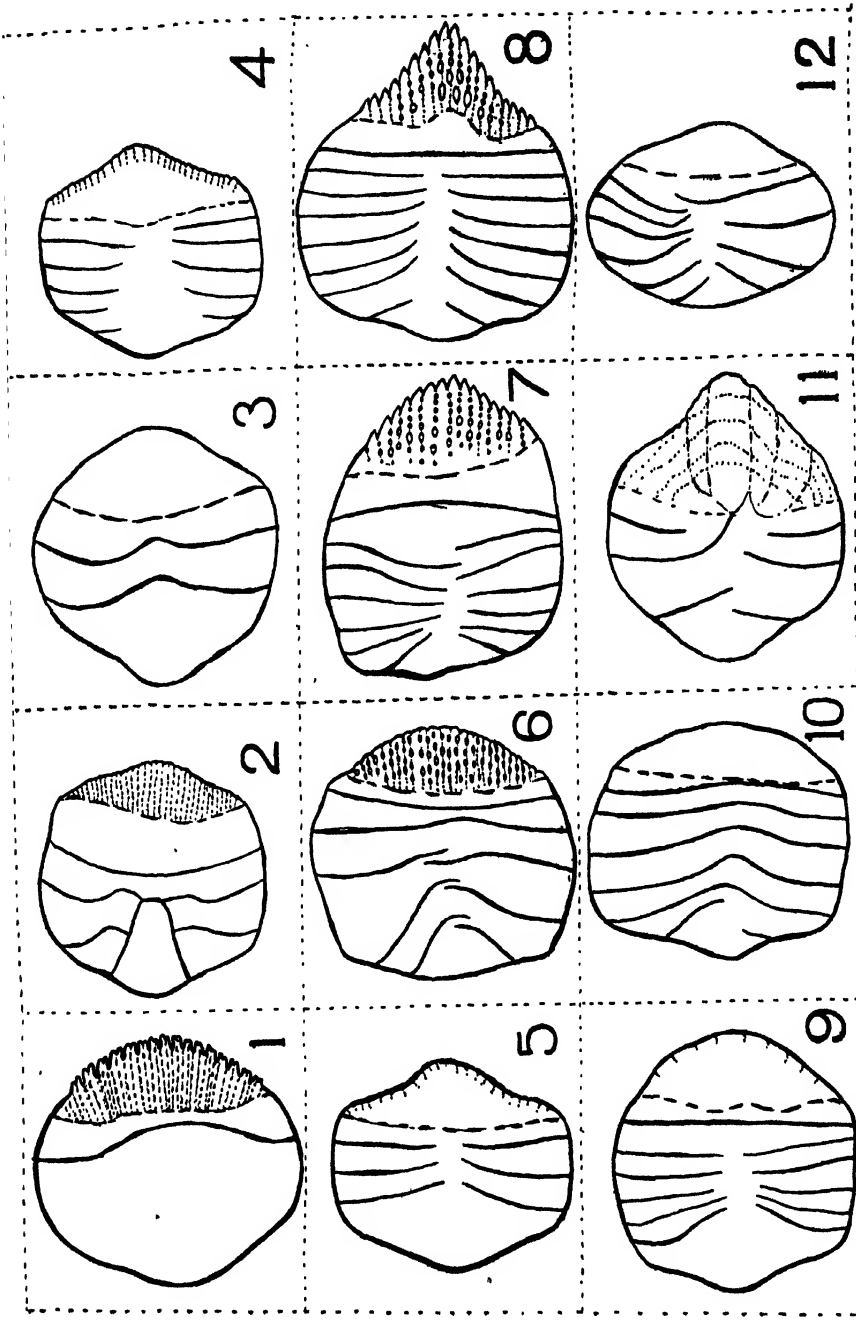
Clupea (Harengus) moluccensis (Blkr)

P. E. P Deraniyagala del.



Opisthopterus macrognathus (Blkr.)

P. E. P. Deraniyagala del



Clupeoid scales

P. E. P. Deraniyagala del.

On the Classification of the Cestoda

BY

T. Southwell, D.Sc., Ph.D., A.R.C.Sc.

Lecturer in Helminthology,
Liverpool School of Tropical Medicine, University of Liverpool

WITH TWO PLATES

INTRODUCTION

Any investigator, who has devoted much time and thought to the study of any particular group of animals, will have recognized clearly and probably painfully that a satisfactory system of classification is a matter of great difficulty, even if it is not altogether impossible. The reason why this is so soon becomes obvious. In nature, the hard and fast distinctions which are arbitrarily drawn by naturalists between species, genera, families, orders, classes, and even phyla, rarely exist. Like the boundaries between counties, states and countries they are usually artificial. Surely it is reasonable to realise and admit a simple and evident fact, viz., that the forms of life are very plastic, very diversified, and frequently merge into each other by almost imperceptible gradations, with the result that no system of classification can possibly be entirely adequate. The utility of a good scheme of classification lies in the fact that it enables us broadly to classify our knowledge and identify species. All systems of zoological classfication are unnatural, although it is true that some are more satisfactory than others.

With reference to the classification of the Cestoda it has been usual during recent years to divide the class into four orders, viz. :—

(1) *Cyclophyllidea* ; in which the head bears four suckers.
(2) *Pseudophyllidea* ; in which the head bears two sucking grooves.
(3) *Tetraphyllidea* ; in which the head consists of four ear-like lappets.
(4) *Trypanorhyncha*; in which the head bears four proboscides, these being protrusible filaments, armed with spines, and retractile.

There are a very small number of parasites in which the head is different from any of those included in the above four orders. All these have recently been referred by the writer to a new order—the Heterophyllidea. In addition to the form of the head, however, *each order is further differentiated by numerous other characters which need not be detailed here.*

It will be clear to cestodologists that the orders Pseudophyllidea and Trypanorhyncha are quite distinct, and so in fact are the two remaining orders. Theoretically, however, it may be quite possible to confound, say, a Cyclophyllidean sucker, borne on a stalk, with a Tetraphyllidean, pedunculated, modified bothridium. In such cases the system fails now and again, and one has then to rely on the other characters referred to above. This system of classification does not owe its origin to the present writer. Braun (1900), Lühe, (1910) and Meggitt (1924) have all adopted it and the writer merely accepts it, because, in his opinion, it is the best that can be devised, at least in the present state of our knowledge. It has this advantage, that, the form of the head almost invariably suggests the order to which the worm belongs.

In all other systems hitherto proposed, the worm has to be sectioned, stained, and certain morphological characters determined before even the order or family to which it belongs, can be ascertained.

The tendency amongst modern systematists is to discount the value of external characters and to base the classification of orders, families, etc., on internal anatomical details. I confess that in the Cestoda I know of no justification for this attitude. In my opinion, the head is as important and as necessary a part of the anatomy as, say, the muscular system, and as useful systematically. Throughout the entire animal kingdom the broad schemes of classification are based in very large measure on external characters. Schneider in 1866 attempted to classify the Nematoda on certain peculiarities of the muscular system. His scheme is now wholly discounted, because it was found that worms closely related to each other in every other way were nevertheless widely separated when classified on the muscular system ; other worms as widely different as possible from each other yet had a certain type of muscular system in common ; whilst other worms combined two types of muscular system in the one individual.

Worms of the class Cestoda have a head, one or more segments, excretory, nervous, muscular, and reproductive systems. Should we separate those parasites which, say, possess only one lateral nerve

on each side and place them in one order; those with two lateral nerves on each side in another order, and so on?

Or should we base our classification upon the character and disposition of the longitudinal excretory vessels, placing those forms with a large dorsal and a small ventral vessel on each side in one order and those with a small dorsal and a large ventral vessel in a second order?

Again, should we be justified in classifying the cestodes on the muscular system, according to the number and arrangement of the muscle layers?

Lastly, the reproductive system might be used as the basis of classification. For example, one order might contain those forms with 50 or less testes, a second order 50–100, and so on. Or the ovary or vitelline glands might be used for taxonomic purposes.

The ovary is sometimes unilaminate and sometimes bilaminate with stages between; the vitelline glands are either condensed into a single mass or the acini are scattered and lie either in the lateral fields or surrounding the segment. Are they in the cortex or the medulla or in both, and if so in what proportions? Special consideration could be given to cases where the demarcation between cortex and medulla is said not to exist, even though where it does exist the distinction between the two is purely an artificial one.

All the above systems of classification would prove most unsatisfactory, either singly or collectively.

On the other hand, I place a definite value on the head, and I would especially point out that although a little variation is found in the head, every other organ will also be found to vary, as we shall see later on; and the head, being so easy to examine, is consequently, in my opinion, of greater value than any other single organ. Moreover, one might enquire in what particular way the classification, if based on any of these systems is more natural, or more satisfactory than if based primarily on the head.

One continually hears the plea for a natural system of classification. I must admit that I do not know exactly what is meant. Owing, as I have previously stated, to the fact that in Nature forms merge into each other, whatever the organ or organs may be, our schemes of classification will sever closely related forms, concerning which different people will hold differing opinions. It is, however, as well to remember that it is as natural for a cestode to have a head as an ovary or a muscular system, even though the cestodean head has, for totally inadequate reasons, fallen into disrepute.

Woodland, for instance, recently stated that in his opinion "scolex characters count for very little." The same remark applies equally well to the muscular system, the vitellaria, reproductive system, etc.

Let us suppose, for instance, that the muscular system of a species of *Dibothriocephalus* (Pseudophyllidea) was found to be identical with that of a species of *Taenia* (Cyclophyllidea) and also with that of a species of *Phyllobothrium* (Tetraphyllidea). We should be obliged to place these species together, because they have a common type of muscular system. Clearly the result would be chaos. Nevertheless it is a fact, as we shall see later, that many species in each of the three above-named orders have an identical muscular system. The matter is of importance because recently Woodland has furnished us with a diagram shewing that the muscular system is of one type in Tetrarhynchidae, of another type in Tetraphyllidae, and of still another type in Proteocephalidae (Cyclophyllidea.) A reference will be made later on to this point, but it is of interest to note in passing that the distinctive muscular system presumed by Woodland to be attributable to each of the groups he names is no more uniformly typical (and much less distinctive) than is the case with the head. In addition, the arrangement of the muscular system is certainly more difficult to determine than is the form of the head; and further it varies widely in different parts of an individual worm. No one has yet stated what specific advantage is gained by changing the basis of classification, but the disadvantages are very obvious. When we are informed that the muscular system of the three groups named above is distinctive for each, the reply is:—(a) The statement that the three types of muscular system characterize the three groups named is to be explained on the ground that Woodland's paper is based on the examination of 14 species only; and (b) if we suppose it to be true that the three groups do actually possess a different type of muscular system, then this fact strengthens the ground for believing that the head, which is also different in each group is as important in diagnosis as any other organ.

POCHE'S CLASSIFICATION

A large monograph of 458 pages on the Platodaria was produced by Poche (1923). This work is quite beyond the scope of the present discussion except in the case of his Cestoidea.

In the commonly accepted schemes of classification, animals in general are divided into phyla, classes, orders, families, genera and species. Poche proposed to extend this scheme in the following manner:

(a). Animals are divided into regna, phyla, etc.. as above.

(b). Each regnum, phylum, class, order, tribe and family is further subdivided; *e.g.*, a phylum is subdivided by Poche as follows :—

Super superphylum,
Superphylum,
Subsuperphylum,
Phylum,
Supersubphylum,
Subphylum,
Subsubphylum.

Poche's classification is as follows :—

Phylum **Platodaria.**

Sub-phylum I. *Platodes*
 Class (1). *Turbellares*,
 (2). *Trematoda*,
 (3). *Cestoidea.*
Sub phylum II. *Nemertarii.*
 Class (4). *Nemertoidea.*

Poche subdivides the *Cestoidea* as follows :—

Subsubclass (I). *Amphilinoinei.*
 Order 1. *Amphillinidea*
 2. *Gyrocotylidea*
Subsubclass (II). *Taenioinei.*
 Order 1. *Bothriocephalidea*
 2. *Echinobothriidea*
 3. *Tetrarhynchidea*
 Suborder 1. *Haplobothriinea*
 2. *Tetrarhynchinea*
 4. *Taeniidea*
 Suborder 1. *Phyllobothriinea*
 2. *Taeniinea*

Thus the entire class Cestoidea is divided into two subsubclasses (*sic*), the first (Amphilinoinei) containing a small number of forms, whilst the second subsubclass (Taenioinei) includes all the rest of the cestodes. Poche unites in his order Taeniidea the entire orders Cyclophyllidea and Tetraphyllidea calling the latter suborder Phyllobothriinea and the former suborder Taeniinea.

His order Echinobothriidea is a pure synonym of Southwell's order Heterophyllidea. The order Tetrarhynchidea is divided into two sub-orders, one of which contains a single species only, viz. *Haplobothrium globuliforme.*

As it is proposed to refer in particular to the Tetrarhynchidea and Taeniidea, Poche's classification of these orders is given in detail below :—

Order **Tetrarhynchidea** nom. nov.
= *Trypanorhyncha* Diesing.

Sub-order I. *Haplobothriinea* nom. nov.

Family 1.—*Haplobothriidae* Meggitt, 1924.

Genus :—*Haplobothrium* Cooper, 1914.

Sub-order II. *Tetrarhynchinea* nom. nov.
Trypanorhyncha Nybelin, 1918.

Sub-tribe (1) *Tetrarhynchoinae* nom. nov.
= *Rhynchobothria* Diesing, 1850.
= *Thecaphora* Diesing, 1850.
= *Trypanorhyncha* Diesing, 1863.

Family 1.—*Tentaculariidae* nom. nov.

Genera *Tentacularia* Bosc = *Tetrarhynchus* Rud.
Eutetrarhynchus Pintner.
Tetrarhynchobothrium Diesing.
Stenobothrium Diesing
Lakistorhynchus Pintner.
Acoleorhynchus Poche, 1925, for *Tetrarhynchus*
hynchus equidentatus Shipley & Hornell, 1906.
Nybelinia (for *Aspidorhynchus* Molin) Poche, 1926.
Synbothrium Diesing.
Abothros Welch.
Floriceps Cuv.
Wageneria Monticelli.
Halsiorhynchus Pintner.
Sphyriocephalus Pintner.
Dibothriorhynchus Blainville.
Otobothrium Linton.

Sub-tribe (2) *Aporhynchoinae* nom. nov.

Family 1. *Aporhynchidae* nom. nov.

Genus *Aporhynchus* Nybelin.

Order **Taeniidea** nom. nov.

Sub-order I. *Phyllobothriinae*.

Family 1. *Onchobothriidae*.
2. *Phyllobothiidae*.
3. *Lecanicephalidae*.
4. *Proteocephalidae*.
5. *Monticelliidae*.
6. *Polypocephalidae*.

Sub-order II. *Taeniinae*. This includes the order Cyclophyllidea as commonly understood. *

Poche stated that the order Tetrarhynchidae embraces those cestodes in which there are many segments which develop progressively posteriorly; the excretory system—at least anteriorly—consists of two dorsal and two ventral vessels; the vasa efferentia unite in the posterior

*The Cylcophyllidea (Taeniinae) and Tetraphyllidea (Phyllobothriinae) are, as noted above, united into one order. (Taeniidae.)

two-fifths of the segment into a vas deferens which runs anteriorly and bears a seminal vesicle.

So far, these characters would apply to almost every cestode, but Poche then stated that the head bears four proboscides and that the vitelline glands are scattered, enveloping the segment; the latter statement is, however, not always correct. It is these two characters, then, which are specific to the order. We are further given a mass of details to the effect that the fibres of the proboscis sacs are inclined at an angle of 90° to those of neighbouring fibres and there is also a long discussion as to whether the proboscis sacs are provided with their own cell layer or not. According to Poche it is clear that Cooper's account (Cooper first described this cell layer) is unintelligible, because Cooper referred to it in one place as a cuticular layer and in another place as an epithelial layer.

What is the objection to stating plainly and simply that the essential feature of this order is the head?

It is reasonable to enquire what justification there is for the proposed re-arrangement, and what useful purpose is served.

A perusal of the paper gives the impression that we have here a work prepared in the library and not in the laboratory, and that the writer, except in the case of the genus *Amphilina*, had no real or first-hand knowledge of the species he discusses. The monograph adds nothing whatever to our knowledge and the paper only serves to intensify the already greatly involved synonymy. It is particularly unfortunate that the orders Tetraphyllidea and Cyclophyllidea should be merged into a new order bearing the name Taeniidea, especially since the following are but some of the derivatives of the word "Taenia" which have already appeared in the literature, viz.:—

Taenioides Risso, 1826; *Taeniaceae* Tschudi, 1837; *Taenioidea* Zwicke, 1841; *Téniodés* Dujardin, 1845; *Taenoidea* Diesing-Seeger, 1852; *Taeniadae* Baird, 1853; *Taeniodea* Diesing of Goldb., 1855; *Taeniadea* Carus, 1863; *Taenidae* Storer-Scudder, 1884; *Taeniidae* Ludwig, 1886.

A similar remark also applies to the introduction of several other names. In fact the classification abounds with new names, erected to supersede existing names, there being, in my opinion, no reason or justification for the procedure. For instance, Poche's new tribe Tetrabothrioides was submitted in place of Fuhrmann's family Tetrabothriidae; his order Tetrarhynchidea for Diesing's order Trypanorhyncha, and so on. In many instances the characters of his new orders, tribes, families, etc., were not defined, and where they were defined they were for the most part those of the order, family, etc., which he had placed in synonymy. There are numerous anomalies in his system

of classification. In one case a new sub-order was erected for the genus *Haplobothrium*, whereas in another instance the genus *Aporhynchus* was made the type-genus of a new family and the family was also placed in a new sub-tribe.

Of the six orders established by Poche only one was definitely defined, viz. the order Tetrarhynchidea.

No one has hitherto been able to identify Molin's genus *Aspidorhynchus*, owing to the fact that Molin did not give an adequate definition of the genus. As the name was preoccupied by a genus of fishes, Poche substituted the name *Nybelinia* in place of *Aspidorhynchus*. The only information we are given regarding the genus is that "According to Braun the grounds put forward by Molin for erecting this genus have reference to the form and position of the bothridia and the telescopic neck possessed by the worm. Nevertheless, Diesing included the genus in his *Tetrarhynchobothrium*. Since Braun wrote this, the distinctions between each genus of parasitic Platodes have been drawn much tighter than formerly, and quite rightly. The peculiar convex shape of the bothridia now forbids the inclusion of the genus with *Tetrarhynchobothrium* Diesing, and no more can it be attributed to any other hitherto known genus of Tetrarhynchidae."[1]

So we are to distinguish this genus because of the peculiar convex shape of the bothridia.

Poche's reasons for uniting the orders Tetraphyllidea and Cyclophyllidea into a new sub-order Phyllobothriinea were summarized in his statement that the distinction between them consists only of differences in the position and form of the vitelline glands. Such a difference, together with suckers on the head which differ just as widely in form in the two groups, would appear to be the strongest of all possible reasons for keeping these orders distinct. The writer in 1925 placed the two families Proteocephalidae and Monticelliidae in the order Cyclophyllidea on account of the fact that the worms in both families possessed, amongst other things, four suckers. Poche removed them to the Tetraphyllidea. He stated that "The justification for placing the two families Proteocephalidae and Monticelliidae in the Phyllobothriinea (Tetraphyllidea) and not, as often happens, in the Cyclophyllidea has received new support owing to the presence of uterine openings in several species of *Proteocephalidae* and this justification is set forth by La Rue in 1914. Recently Southwell concluded that 'it is better to classify these orders on the form of the head rather than on the configuration of the vitelline glands, for although difficulties

1. In several instances in the present paper translations from quotations of Poche and Pintner are placed within quotation marks for the sake of convenience and clearness.—Ed.

arise in connection with these two orders the difficulties are not so great as if the classification is based on the vitelline glands. Further, whilst it is easy to examine the head, it is more difficult to determine whether the vitelline gland is single or multiple.' On this ground, Southwell places the Monticelliidae, Polypocephalidae and Lecanicephalidae in a sub-order Multivitellata. I am unable to agree with Southwell; for it stands in absolute contradiction to the very foundations of a natural classification to limit orders or sub-orders by a so insignificant external character, such as any particular form of sucker."

The fact is that the particular sub-order was not limited by the form of the head, but by a combination of characters which included the head and the vitelline glands. One may note here that whilst Poche complained that the writer generally limits, for instance, the order Cyclophyllidea to those forms possessing a head with four suckers, Poche himself limited his own order Tetrarhynchidea to those parasites in which the head bears four proboscides; his sub-order Haplobothriinea to those Tetrarhynchids in which the segments develop secondary segments; his family Lecanicephalidae to those worms with the head characters ascribed by Braun to the family; and his sub-order Aporhynchoinae to those Tetrarhynchids in which proboscides are entirely absent. The conclusion seems to be that a character only becomes important when used by Poche, and that there are occasions apparently when a classification based partly or wholly on the head does *not* stand in absolute contradiction to the very foundations of a natural classification. Poche leaves us entirely in the dark as to what he considers are the morphological characters on which a natural classification should be based, or for that matter on what he bases his own classification, but an illustration of the so-called natural character of his scheme may be usefully considered here.

Acoleorhynchus.

This genus was established by Poche to accommodate *Tetrarhynchus equidentatus* Shipley and Hornell, 1906. In this species the proboscis sacs are said to be so close to the anterior extremity of the head that there is no room for proboscis sheaths, and the latter are consequently absent. The species is especially distinguished by having the posterior extremity of the head produced backward into an extremely conspicuous collar which overhangs the anterior segments, a character which it shares with all the following species, viz.:—

Tetrarhynchus lingualis Cuvier, 1817.

Tetrarhynchus robustum Linton, 1890. (Syn. *T. narinari*. MacCallum, 1917).

Tetrarhynchus tenue Linton, 1890.

Tetrarhynchus herdmani Shipley & Hornell, 1906.

Tetrarhynchus perideraeus Shipley & Hornell, 1906.

Tetrarhynchus equidentatus Shipley & Hornell, 1906.

Tetrarhynchus palliatus Linton, 1924.

In all these species the hooks on the proboscides are extremely minute, practically equal in size, and arranged in a spiral. If there is such a thing, they form a natural group, which is known as the *lingualis* group on account of the fact that *T. lingualis* is the best known and was discovered first. The position of the proboscis sacs within the head is shewn in Plate XXXI. On account of the fact that the sacs are nearer the front end of the head in *T. equidentatus* than in any of the other, this species is selected by Poche as the type of a new genus. The predominant features of this group of worms are the collar and the small equal-sized hooks—the two points which unite them in a natural classification—but, ignoring the natural features which they have in common, Poche fixed on a minor and more inconspicuous character and, selecting the species in which the sacs are quite anterior, made it the type of a new genus. If the position of the sacs is the important point, then let us be uniform and place together in the same genus those in which the sacs occupy the same relative position. Pintner (1928b) has since examined and figured this species. His figure shows the proboscis sacs situated in the posterior half of the head, and moderately long proboscis sheaths are present. Pintner rightly retained the species in the genus *Tetrarhnychus*.

Tylocephalum.

This genus comprises a series of worms in which the head presents a very typical appearance. It is made up of two flattened spheres, one in front of the other, and the posterior one bears four suckers. In most species the vitelline glands are scattered, but in at least one species, viz. *T. uarnak*, they are condensed into a single mass. Poche pointed out that if the gland is single in the latter species it cannot possibly belong to the genus. Clearly it all depends on what character or characters the classification is based. If based principally on the head, then it undoubtedly belongs to *Tylocephalum*; if on the vitelline glands or testes, etc., then it does not. In my opinion the form and appearance of the head is, in this case, the important diagnostic character, and the disposition of the vitelline glands is not of generic importance. Poche pointed out the extreme likelihood of the writer having mistaken the testes for the ovary and the ovary for the vitelline glands in the above species, and he further stated that he believed that Linton has made a similar mistake in his figure of *Discocephalum pileatum*.

It is improbable that Linton, who has been working at this subject for over fifty years, would make a mistake of this nature over a point of ordinary elementary anatomy. In any case, statements of this sort might have carried some weight if Poche had previously examined the material.

It would appear, therefore, that this classification by Poche is, so far as the Cestoda are concerned, very unsatisfactory. His scheme is impracticable and illogical, and one can only agree with Woodland (1928) that Poche's paper "affords an almost amusing contrast with the system of classification advocated by Southwell."

WOODLAND'S CLASSIFICATION

W. N. F. Woodland (1927) recently published a paper in which he proposed a revised classification of the Tetraphyllidea. Woodland's classification differs widely from that of Poche on major points for, whilst Poche unites the orders Cyclophyllidea and Tetraphyllidea into one order (Taeniidea)—retaining the order Trypanorhyncha,—Woodland unites the Trypanorhyncha and the Tetraphyllidea, (together with Proteocephalidae) into one order Tetraphyllidea, keeping the order Cyclophyllidea distinct. Woodland divides the Cestoda into three orders, viz. the *Pseudophyllidea*, the *Cyclophyllidea* and the *Tetraphyllidea*; the latter order is usually divided into two families, viz. (a) the Onchobothriidae embracing those forms with an armed head, and (b) the Phyllobothriidae comprising those species in which the head is unarmed. Woodland now includes in the order Tetraphyllidea three families, viz. (1) the *Phyllobothriidae* (*sens. nov.*) to include, with or without distinction, the old families Phyllobothriidae and Onchobothriidae; (2) the family *Proteocephalidae*; and (3) the entire order Trypanorhyncha which he refers to as the family *Tetrarhynchidae* Cobbold.

The characters of the order Tetraphyllidea (*sens. nov.*) are not given and one is left to guess how this order differs from the other two.

Table I (page 60) sets forth the essential characters of the three families included in the Tetraphyllidea (*sens. nov.*) as given by Woodland:

Summarizing these distinctions, Woodland stated that the diagnostic characters of the three families are as follows :—

Phyllobothriidae (*sens. nov.*). "Presence of phyllidea not associated with proboscides, single zone of longitudinal muscle bundles more or less co-extensive with the subcuticula, and the combination of a quadripartite ovary with a vagina dorsal to uterus; and lastly marginal vitellaria."

Tetrarhynchidae Cobbold. "Head with armed proboscides, and distinct internal layer of longitudinal muscle bundles. Vitellaria

Table I.—Giving the essential characters of the families of the Tetraphyllidea (according to Woodland)

	Phyllobothriidae	*Tetrarhynchidae*	*Proteocephalidae*
Scolex	Armed or unarmed, usually 4 bothridia	2 or 4 bothridia associated with 4 armed retractile proboscides	With 4 suckers
Genital pores	Marginal and usually irregularly alternate	Marginal and usually irregularly alternate	Marginal and usually irregularly alternate
Parenchyma	Not divided into cortex and medulla by longitudinal muscles	Not divided into cortex and medulla by longitudinal muscles	Usually divided into cortex and medulla
Longitudinal muscles	Restricted to subcuticular area, all organs being internal to longitudinal muscles	Thin subcuticular layer and a thicker internal layer which latter is not always present	Consists usually of an internal layer
Vitellaria	In 2 marginal strands except in a few species where they envelope the segment especially in immature segments	Always concentric, never in 2 marginal strands	Usually in 2 marginal strands, but often prophetic of a Cyclophyllide condition
Ovary	Quadripartite assuming an X-shape in cross section, except in a few species	Quadripartite assuming an X-shape in cross section, except in a few species	Always unilaminate
Vagina	Ventral to uterine duct and dorsal to uterine sac	Ventral to cirrus sac and uterine sac	Dorsal or ventral to cirrus sac, but always dorsal to uterine sac
Uterus	Consists of a ventral duct and a sac anterior to ovary	Consists of a ventral duct and a sac anterior to ovary	Frequently consists of a duct and a sac
Uterine pore or pores	Late in development and always preformed	Late in development and always preformed	Ventral preformed pores present, or extensive longitudinal slits
Gravid segments	Frequently, but not always, becoming detached and free living	Frequently but not always becoming detached and free living	Rarely separate from strobila and then only terminal segment
Hosts	Elasmobranch fishes	Elasmobranch fishes	Fresh water fishes, amphibia, reptiles

enveloping the segment and a vagina situated *ventral* to the uterus and cirrus sac."

Proteocephalidae. Head with four suckers, a unilaminate ovary and lateral vitelline glands.

In considering the proposals set forth by Woodland, it may be stated at once that it is a point of little importance whether a group of worms is given the rank of family or order, etc. The widest diversity of opinion exists on such matters. In every division of animals the systematic value of a character, or of a combination of characters, is assessed differently by various workers.

The relationship or affinity of one family or order of parasites to another is a difficult question on which it is clearly impossible to dogmatize. The important point is to decide what are the salient features by means of which groups of worms can be differentiated from each other. If we examine the main characters given by Woodland for his three families noted above, we find that :—

(1). *Head.*

His primary distinctions are based on the head, *e.g.* in one family the head has four bothridia, in another it has four suckers and in the third it has four proboscides. In view of the fact that each of these three families is stated by Woodland to have a distinctive type of head, one fails to understand his statement elsewhere that "with me, scolex characters count for very little." Assuming for the moment that all the other characters given by him for each family are correct they only strengthen and consolidate the ground for believing that the value attached by most modern writers to the form of the head is well founded.

(2). *Parenchyma and longitudinal muscles.*

The parenchyma in many species of Cestoda can frequently be differentiated into two parts ; the portion lying between the cuticle and the *circular* (not longitudinal) muscle fibres is known as the cortical parenchyma, whilst that lying internal to the circular muscles fibres is known as the medullary parenchyma. Woodland (1925) stated that in his new family Phyllobothriidae " the parenchyma is not divided by an internal layer of longitudinal bundles into cortex and medulla, the longitudinal musculature being restricted to an undivided peripheral zone of fibres and bundles of fibres lying immediately internal to the thin circular muscle layer underlying the cuticle and more or less co-extensive with the subcuticula." (p. 533). It is not clear from this statement whether Woodland considers that the parenchyma is not divided into cortical and medullary portions at all or whether the parenchyma *is* so divided, but that the longitudinal muscles (sic) are not situated at the junction of the two parts. His figures indicate clear

divisions between the two and Plate IV, Fig. 49, shows "the fibrillated sheet" (in transverse section) separating the "medulla" from the "cortex" in a typical Phyllobothriid, viz. *Phyllobothrium unilaterale.* He wrote that "One remarkable and very characteristic feature which at once strikes the eye in transverse section is the presence of a very thin, but very black line which separates on all sides the central region of the medulla occupied by the chief organs from the peripheral region of the cortex wholly occupied by the subcuticula and the longitudinal muscle bundles. This line is fibrillated (Fig. 49), some of the fibres penetrating at right angles to the line into the subcuticula and running between the longitudinal muscle bundles. This line may represent a thin circular muscle layer, but if so it is unusually darkly coloured and I have not seen its like in other Phyllobothriidae" (p. 528).

He further added (p. 538) that in at least three genera of the Proteocephaliidae the cortex and medulla are well separated by circular fibres.

Woodland's revised classification of the Tetraphyllidea is based on the examination of fourteen species of which twelve are specified; of these twelve, in one (viz. *Phyllobothrium unilaterale* Southwell, 1925) he actually figured and described the cortex and medulla. In nine other species the muscular system and parenchyma were not described at all; in the eleventh species (viz. *Onchobothrium pseudo-uncinatum*) the cortical portion containing "the longitudinal muscles are, contrary to Southwell's statement, very well-developed in mature proglottides (Fig. 58), though it is true that in ripe proglottides with distended uteri, the whole subcuticular region becomes reduced in thickness." In the remaining species, *Acanthobothrium dujardinii,* he states "so far as I could observe them the longitudinal muscles and nerves are of the usual type."

Had Woodland's investigations been of a more extensive nature he would have found that this statement has no basis in fact, and, as we have seen, it is not even true in some of the species he describes. It will be realized that the examination of such a small number of species provides wholly insufficient grounds on which to base statements regarding the characters of two orders, even if his assertions were true in all the cases examined, and a revision of an order, whether of Nematodes, Trematodes or Cestodes, based on the examination of 14 species, cannot be considered as a serious or reliable contribution to our knowledge. In point of fact, both the muscular system and the parenchyma vary within very wide limits in the old order Tetraphyllidea. In the larger species the transverse diameter is due principally to the development of the longitudinal musculature and parenchyma; in slender and delicate

species the longitudinal muscles and parenchyma are correspondingly reduced. But even in the larger species the longitudinal musculature varies enormously. In some, the fibres are condensed into numerous very stout bundles encircling the segment, and occupying almost all the cortex, whilst in others the bundles of fibres are extremely small and scattered irregularly throughout the cortex, appearing in stained transverse sections, as minute darkly-stained points. But the variations in form and development of the muscular system within a single individual are even more striking, and in many species the distribution and arrangement of the longitudinal muscles are quite different in very immature segments from the condition seen in mature segments, and they are quite different again in gravid segments. This applies in particular to those species in which the longitudinal muscle bundles are larger and well-developed. I do not remember having examined a single species in which a cortex and medulla were not differentiated, and in all the species which I possess, and which I have re-examined, a cortical and medullary parenchyma is clearly defined. The longitudinal muscles either (a) occupy varying proportions of the cortical parenchyma in the form of rather large compact bundles, or (b) are insignificant and scattered irregularly as small fibres in the cortical tissue.

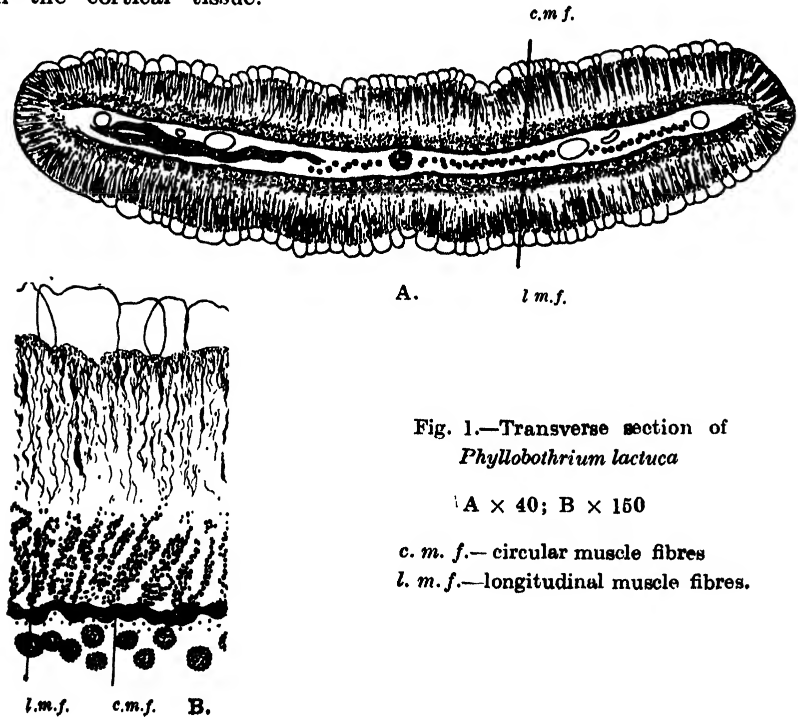


Fig. 1.—Transverse section of *Phyllobothrium lactuca*

A × 40; B × 150

c. m. f.— circular muscle fibres
l. m. f.—longitudinal muscle fibres.

Text fig. 1. is a *camera lucida* drawing of a transverse section of *Phyllobothrium lactuca*, the type species of the type genus of the family. It will be seen that the longitudinal musculature is strongly developed; that the fibres are not subcuticular; and that the internal layer of circular muscles dividing the parenchyma into cortex and medulla is very well-developed; in fact the musculature, in great detail, resembles that of *Taenia crassicollis* and the majority of the species of Cyclophyllidea. In the author's monograph on the Tetraphyllidea (Southwell, 1925), it will be seen that in at least three other genera, out of a total of eight, the musculature resembles that of *P. lactuca*, viz:—

Uncibilocularis trygonis Shipley and Hornell, 1906 (page 97, fig 52.)

Pedibothrium globicephalum Linton. 1909 (p. 109, fig. 62), and

Thysanocephalum crispum (Linton, 1889) (page 122, fig. 72), whilst in the Pseudophyllidea an exactly similar musculature is found in many species (see Cooper, 1918 and Nybelin, 1922).

Thus there is ample proof that in the Phyllobothriidae Woodland's statement is incorrect. Of the family Tetrarhynchidae, Woodland examined two species only, and in one of them "the internal layer of bundles is not always present (I cannot detect it in *Tetrarhynchus tetrabothrium* e.g) though usually so."

(3). *Position of organs relative to the longitudinal muscle layer.*

According to Woodland, in the *Phyllobothriidae* "all the organs except the lateral nerves lie internal to the longitudinal muscle layer" (p.533). Lühe (1910) and Meggitt (1924) state that the vitelline follicles in this order are situated in the cortex. The writer found them external to the longitudinal muscle layer in *Thysanocephalum crispum* Linton, 1889, and *Pedibothrium globicephalum* Linton, 1909. In the genera *Tylocephalum, Cephalobothrium* and *Balanobothrium* they lie internal to the longitudinal muscles whilst in the genus *Adelobothrium* they are intermingled with the longitudinal muscles.

Cooper (1918) stated that the glands are mostly cortical, seldom medullary, in the Pseudophyllidea. He figured them external to the longitudinal muscles in *Bothriocephalus claviceps*, *B. cuspidatus* and other species, and internal to the muscles in *Abothrium rugosum*. Nybelin (1922) in his monograph on the *Pseudophyllidea* figured the glands external to the longitudinal muscles in three species of *Eubothrium*, whilst in other species of this genus the glands are intermingled with the muscles. In the genera *Parabothrium, Abothrium* and *Priapocephalus* the glands are internal to the longitudinal muscles.

All authorities agree that the glands in the Tetraphyllidea vary in that, whilst they are usually in two lateral strands, they occasionally

envelope the segment. In the Tetrarhynchidae Woodland found that the glands were concentric in the two species at his disposal. He also pointed out that "in the Phyllobothriidae the vitellaria are disposed in two marginal strands, (though traces of a concentric, *i.e.* annular in transverse sections arrangements are visible in the immature proglottid in a few species)" (p. 533). The writer's observations show that the vitellaria in the Phyllobothriidae almost invariably appear first as lateral strands, which in many species develop to an annular arrangement in posterior segments, but I have never seen a species in which antero-posteriorly the development was from annular to lateral.[1]

(4). *Ovary.*

In the Phyllobothriidae and Tetrarhynchidae the ovary according to Woodland is quadripartite, *except* in a few species. On this point I am not in a position to express an opinion. Even if it is true it provides no basis for differentiating members of the two orders, and, moreover, the determination involves section-cutting and staining. The ovary is only described in five of the species investigated by Woodland and in two of them it is not X-shaped ; viz. in *Anthobothrium cornucopia.* "The ovary in this species is not strictly X-shaped in transverse section as Fig. 45 shews, but is irregular in form........" (p. 527). Again in *Acanthonothrium coronatum* we read (p. 527) "The ovary is not strictly X-shaped..........."

(5). *Vagina and uterus.*

According to Woodland, the vagina is dorsal to the uterine sac in the Phyllobothriidae and ventral in the Tetrarhynchidae. I cannot say whether this is true or not. In any case it is unsafe to make a definite statement of this sort on the examination of fourteen species.

(6). *Uterine pores.*

Woodland stated that the uterine pores in both orders are late in development and are always preformed. In most of the species examined by Linton, who has been working at this group since 1879, no uterine pores were discovered, and this experience coincides with that of the present writer. In a few species a single uterine pore is definitely present and prominent, but in others no trace of a uterine pore is to be found even in serial transverse sections.

1. In the Tetrarhynchids the vitellaria usually envelope the segment, but there are several species in which they remain definitely lateral.

In *Echeneibothrium maculatum*, a new species described by Woodland, he stated that "I could detect no uterine aperture or apertures in my slide preparation, though when living isolated proglottids were placed on slides, they all immediately shed hundreds of eggs from one or more points, presumably on the ventral surface." (p. 520).

The same phenomenon can be observed at any time with a gravid segment of *Taenia saginata* in which every one agrees that uterine pores are absent. In *Echeneibothrium variabile*, Woodland pointed out that "all my specimens were too young to show the ventral uterine opening" even though they are supposed to be preformed. No mention is made of a uterine pore, either preformed or otherwise, in his account of five of the twelve species, viz.—*Acanthobothrium dujardinii*, *Acanthobothrium coronatum*, *Echeneibothrium julievansium*, *Scyphophyllidium giganteum* and *Phyllobothrium unilaterale*.

In *Onchobothrium pseudo-uncinatum* he found that "a short uterine duct is present.................... This is a sign that a definite uterine aperture (if such exists) is of very late development" (p. 532); in the appendix two other species without uterine pores are quoted. His evidence seems wholly inconclusive.

It will be clear that the essential characters which Woodland attributed to two of his families are by no means constant and that in point of fact they are more variable than is the case with the head.

Discussing the family Lecanicephalidae, Woodland concluded from the muscular system and from the lateral vitelline glands that a number of genera now placed in that family belong to the Phyllobothriidae and he proposed "subject to the species above named being ultimately proved to be Phyllobothriids that the genera *Lecanicephalum*, *Cephalobothrium*, *Balanobothrium*, *Polypocephalus* and *Calycobothrium* be included in this family." It would be just as logical and as helpful to say that *subject to their being ultimately proved to be* Phyllobothriids the genera *Taenia* and *Dibothriocephalus* should also be placed in the same family.

Of the two remaining genera of the family *Lecanicephalidae*, *Adelobothrium* and some species of the genus *Tylocephalum* are referred to *Tetrarhynchidae*, whilst other species of the genus *Tylocephalum* are not relegated to any family and Woodland was compelled "to await the results of further investigation before attempting their classification" (p. 537).

Reference has been made above to the fact that in at least one species of the genus *Tylocephalum* the vitelline gland is single; Poche, as we have noted above, was of opinion that the observation is incorrect, and Woodland agreed with him. Pintner, however, has since shown (1928b) that the gland is single in *T. uarnak*.

I have previously pointed out that in the present state of our knowledge the head provides a reliable general character on which broadly to classify the Cestoda; other characters are, however, invariably taken into account. It is true that there are a few species which cannot be classified satisfactorily on the head alone; and further, I have stated that if any other morphological feature be used as a basis of classification, it is likely that the variations in that organ will be found to be as great, if not greater, than is the case with the head. We have seen that such is the fact and Woodland himself noted that "The great variety to be found in Bothriocephalid anatomy indeed prepares us for meeting anomalous combinations of characters in some species........Cohn's *Prosobothrium armigerum*........is an example. This form combines concentric vitellaria (a Tetrarhynchid character) with a unilaminate ovary (a Proteocephalid character) a single cuticular zone of longitudinal muscles (Phyllobothriid) and a vagina dorsal to the uterus (Phyllobothriid and Proteocephalalid character)." In my opinion such cases serve to emphasize the wisdom of adhering to the simple classification based in part on the head, until a better and more reliable one is devised. Woodland's problem in advocating the inclusion of the three families in one order is "to find deep seated characters common to all which shall distinguish them from the other two orders of Cestoda. Such characters are either very inadequately stated or not stated at all in the definitions of these three orders which occur in current text books and monographs" (p. 540).

If one turns to Woodland's account of his new genus *Scyphophyllidium* (p. 525), one finds that the genus is erected on the examination of a single immature specimen. The entire internal anatomy is given in the following words "I will merely record that the ovary is as usual X-shaped; that two pairs of excretory vessels are present, and that the cirrus and vagina lie ventral to the lateral nerve. The vitellaria were almost entirely undeveloped, but I believe they have the typical Phyllobothriid arrangement." The genus was not defined, but he established it "to receive Phyllobothriid species possessing a simple scolex with bothridia modified into suckers and devoid of a rostellum" (p. 526). It is extremely

probable that had a few specimens been examined alive the new genus would not have been created. In view of the above brief and entirely unsatisfactory description, Woodland's complaint loses its value, and incidentally this immature form cannot be indentified.

In his monograph the writer reduced the number of Phyllobothriid genera from about 28 to 8. Woodland did not "believe that Southwell has gone half far enough in his restriction of the number of phyllobothriid genera." (p. 522). In view of this statement it is difficult to understand why he resurrects one of the discarded genera (viz. Orygmatobothrium) and also why he forms another genus.

Throughout Woodland's paper the head was used along with other features as a differential character for each of the three families he dealt with. Characters other than the head such as the muscular system, vitellaria, uterine pore, etc., are, as we have shown, so variable as to be quite unreliable. It remains to be seen whether his assertion regarding the position of the vagina with reference to the uterus and cirrus pouch is well founded, but even if it proves correct it is associated with a particular type of head, and a head is easier to examine than a cross section.

PINTNER'S CLASSIFICATION

In a very recent paper Pintner (1928b) has dealt at some length with the family Gamobothriidae Linton, 1889 (*not* 1899) (Lecanicephalidae Braun, 1900) and in the same paper he has also suggested the following classification of the Cestoidea.

Class **Cestoidea** Rudolphi

Order 1. *Amphilinidae.*

Families :—*Amphilinidae, Gyrocotylidae.*

Order 2. *Cestodes.* s. str.

Families :—*Bothriocephalidae, Echinobothriidae, Tetrarhynchidae, Tetraphyllidae, Proteocephalidae, Taeniidae, Discocephalidae, Tetragonocephalidae, Cephalobothriidae, Balanobothridae.*

The first order comprises the monozoic cestodes and the second order polyzoic forms. With reference to the latter order it will be seen that all the four old orders, viz. Pseudophyllidea, Cyclophyllidea, Trypanorhyncha and Tetraphyllidea are merely reduced to the rank of family and are referred to as Bothriocephalidae, Taeniidae, Tetrarhynchidae and Tetraphyllidae respectively.

The old family Lecanicephalidae is split up into three new ones and a new family Discocephalidae is formed for the reception of the genus *Discocephalum* which contains only a single species,

viz. *D. pileatum*; lastly the families Proteocephalidae and Echinobothriidae stand alone.

The writer sees no objection to this classification, except that the splitting up of the Lecanicephalidae into three families and the erection of a special family for a single species of *Discocephalum* appears both unnecessary and unjustifiable. Unfortunately, Pintner did not define some of his families and one assumes therefore that the characters of the families Bothriocephalidae, Taeniidae, Tetraphyllidae and Tetrarhynchidae are those of the corresponding order from which they have been reduced.

With reference to the family Gamobothriidae (Lecanicephalidae) Pintner stated that *Lecanicephalum peltatum*=*Discocephalum fallax*; Woodland, however, believed that *Discocephalum fallax*=*Echeneibothrium variabile*. If this is so, then *L. peltatum*=*Echeneibothrium variabile*; this, however, cannot be true; *Lecanicephalum peltatum* and *Echeneibothrium variabile* differ from each other very greatly.

Pintner (p. 88) pointed out (1) that the variability in the shape of the head can easily lead to the establishment of new species, and even genera, if only a small number of individuals are examined. A large quantity of living or very carefully preserved material is essential. (2) The dimensions of the head, chain and proglottides vary considerably without constituting necessarily specific differences. (3) The size, number, shape and position of the reproductive organs are of doubtful importance even as specific characters in pressed preparations. Observations as to the number of the testes are valueless if the degree of maturity of the segment is not taken into account, and with these remarks the writer is in agreement. Pintner's reasons for erecting the four special families are as follows:—

As regards the Discocephalidae. Pintner (1928a) expressed the opinion that there is not the slightest indication in the head region of *Discocephalum* that the cushion or collar is comparable to a bothridium or to the rostellum of *Taenia* or to the form bothridia in the Tetraphyllidea, or in fact to the head of any other tapeworm (p. 87). This is absolutely true. In the present state of our knowledge one does not know whether such a head has been evolved as a result of fusion of 4 bothridia or the loss of 4 suckers, etc.; or whether it is a primitive type from which others arose, or merely an intermediate form. Woodland (1927), in discussing the Proteocephalidae (p. 538) stated that in that family "the phyllidea have become replaced by typical suckers, usually borne on protrusible lobes often only apparent when protruded." It is just as

probable that the reverse is the case and there is not the slightest justification for his statement. Pintner further noted that the vitelline glands differ from those of the Tetraphyllidea, but agree with those of the Tetrarhynchidae. As a matter of fact the gland is single and posterior to the ovary in *Discocephalum* and therefore differs from the condition obtaining in both the above families.

The other three families, viz. Tetragonocephalidae, Cephalobothriidae and Balanobothriidae are distinguished, according to Pintner, principally by the form of the head; whether the head contains glands or not; whether the worms are long or short, craspedot (where there is a division between the head and neck) or acraspedot, cylindrical or generally not cylindrical.

The question of a uterine pore, whether preformed or otherwise, is only mentioned on p. 108 where Pintner definitely stated that in one group (containing *Tylocephalum uarnak*) there is a bilobed uterus with an opening.

In his monograph on the Tetraphyllidea, the writer found that in three species of the genus *Tylocephalum*, viz. *T. uarnak*, *T. minutum* and *T. trygonis*, the vitelline glands instead of being disposed in two lateral strands, as in all other species within the family, were single and situated behind the ovary. As pointed out before, Poche, judging entirely by the writer's figures of these species and not having seen the material, concluded that in *T. trygonis* I had mistaken the testes for the ovary and the ovary for the vitelline glands. Woodland, who also had not seen the material, agreed with Poche. The answer to these assertions is provided by Pintner who *has* examined the material and wrote "I agree with Southwell's description as far as it goes. Southwell says the vitelline glands are single and posterior to the ovary.... it certainly holds good for *T. uarnak*, but in the other two species the vitelline glands start as a single gland, but later form two long lateral rows of follicles...... "

These anterior and lateral prolongations of the vitelline glands are not present in any of the writer's preparations, which number over 70. Quite possibly the posterior proglottides in Pintner's specimens were riper than those I possess.

Woodland noted that "the Bothriocephalid anatomy also shows us great variations in disposition of the vitellaria in that group and in the Proteocephalid *Parabothrium bulbiferum* Nybelin, the vitellaria have almost assumed the disposition just described for the aberrant Lecanicephala species just mentioned," *i.e.* in *T.*

trygonis, *T. minutus*, *T. uarnak* and *Discocephalum pileatum*, and in the Proteocephalidae, where the vitellaria are always in two lateral strands. Woodland mentioned *Ichthyotaenia adhaerens* Linton, 1925, in which the gland is concentric. Since exceptions occur in Bothriocephalids and Proteocephalids there is nothing particularly remarkable in similar exceptions occurring in a Tetraphyllidea. If such variations did not exist systematic zoology would be simple. Knowing that they do occur it is not surprising that schemes of classification, not based on extensive acquaintance with numerous living forms, are found wanting when tested with the bewildering variety found in nature.

It would appear, therefore, that the statements of Poche and Woodland were unfortunately based on the examination of a few species only. Quantities of living and carefully preserved material have been examined by the writer during the last twenty years and this work leads him to regard the conclusions reached by the above authors as quite untenable.

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EXPLANATION OF PLATES

Species of the *Tetrarhynchus lingualis* group

Plate XIX

a.—Head of *T. equidentatus*. × 4.

b.—Head of *T. herdmani*. × 60.

c.—Head of *T. tenue*. × 21.

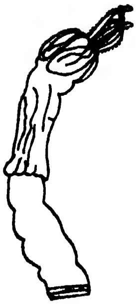
d.—Head of *T. perideraeus*. × 36. (After Shipley & Hornell.)

e.—Head of *T. palliatus*. Magnification unknown. (After Linton).

Plate XX

a.—Head of *T. robustum*. × 36. (After Linton).

b.—Head of *T. lingualis*. Magnification unknown. (After v. Benedin.)



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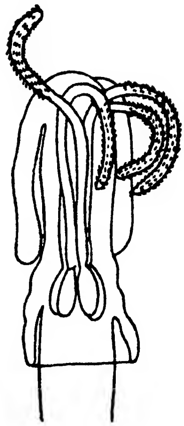

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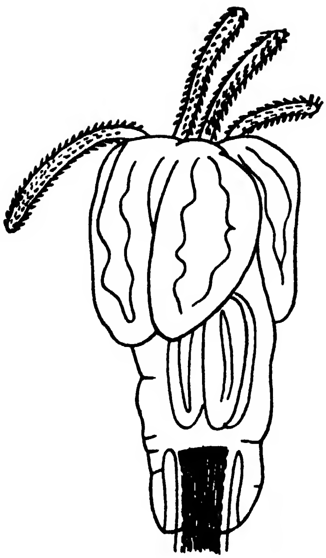

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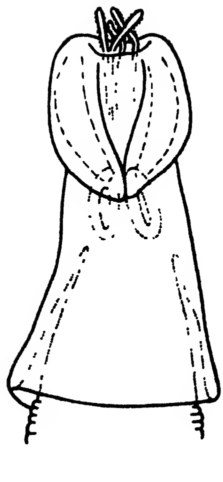

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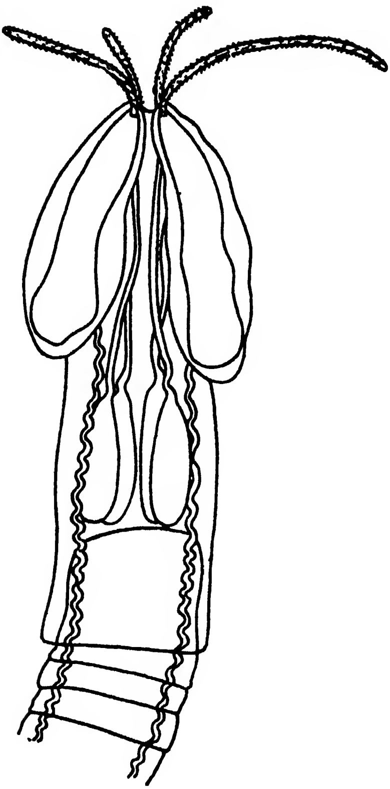

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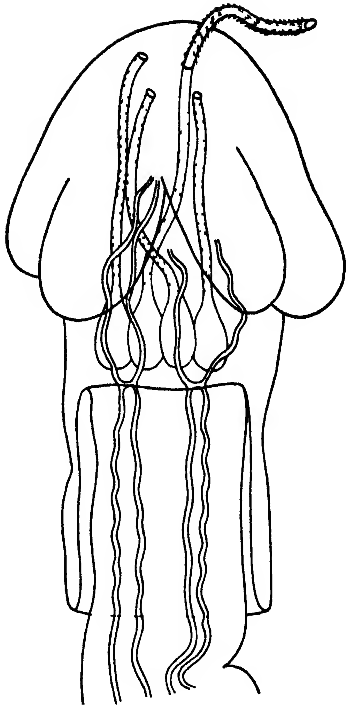


B.

Two New Fresh Water Fishes

BY

P. E. P. Deraniyagala, M.A. (Cantab), A.M. (Harvard)

2nd Assistant Marine Biologist, Fisheries Department

WITH TWO PLATES

Puntius titteya sp.n. (Plate XXI)

Local names. *Lai titteya, (S.)—Crimson bitterling*
Vairan titteya, (S.)—Striped bitterling
Dola titteya, (S.)—Rill bitterling

This form differs from other Ceylon species of *Puntius* in that it is the only one with barbels, which possesses an incomplete lateral line.

Fins. P 1·10. V 2·7. D 3·7. A 3·5. C 17.

Scales. LL 19–20 with 3-5 perforated scales. Length, without caudal fin, 31 mm.

L tr $\frac{3\ 5}{3\cdot 5}$; predorsals 7–8, preventrals 11.

Dorsal profile convex, dropping suddenly after the base of the dorsal fin and sloping down to caudal fin. Ventral profile rather convex but straighter than dorsal profile. Belly smooth and rounded. In old specimens vertex well defined, lower than back, which humps up. Head without scales and contained 3·5 times in the length excluding caudal fin. Single pair of maxillary barbels present, 0·9–1·5 eye diameters in length. Eye free and contained 3–3·5 in head length. Depth of body 2·8–3 in length. Lips narrow. Postlabial groove interrupted in middle. Mouth protractile, slightly inferior. Suborbitals narrow, preorbital small, triangular; preopercular angle somewhat less than a right angle. Opercle rather deeper than long. Gill membranes fused to isthmus at level of hind edge of preopercle. Branchiostegal rays 3, gill rakers 2/4. Pharyngeal teeth 5.3.2. with flattened cusps sloping upward to points.

Dorsal, ventral and anal fins with rounded, convex posterior margins. Undivided rays weak and except in the dorsal fin, smooth. Origin of

dorsal fin in mid back and level with insertion of ventrals. Third osseous spine of dorsal longest and equal to two-thirds of body depth. Posterior upper edge faintly serrate, first and second spines smooth. Base of dorsal in a scaly sheath of about 3 scales. Insertion of ventrals midway between tip of snout and base of caudal fin. A small axillary scale present, ventrals reach anal when depressed. Anal fin reaches middle of caudal peduncle, base in a scaly sheath of two or three scales. Pectoral fin set low down and half a snout length shorter than head. Caudal fin strongly emarginate, exceeds head length by half an orbit. Caudal peduncle with nine scales round its middle, as long as its least depth.

Colour. (In alcohol). A dark brown lateral line extends along the upper lip through mid eye to the posterior extremity of the median caudal rays. Below this line a series of ten blotches which are much deeper than long, extend from shoulder to above anal. Below these are two or three similar blotches, between ventral and anal fins. Dorsally, a yellow median line runs from snout to vertex. Inferior to this lies a black band which is superior to the nares. This line unites with its fellow from the opposite side to enclose the yellow median line in a "U," each end of which broadens out posteriorly on vertex and continues laterally as a diffuse band, over a series of five scales. A thin dark brown median band commences in line with fronto-median yellow band and runs up to origin of dorsal fin. A broad brown dorsal band, including these three dark bands, commences from the nape and extends dorsally to base of caudal fin. This band is separated from the dark brown lateral line by a yellow lateral streak. Ventral and anal fins have their hind margins dusted with black. In a few specimens the tips of the pectorals are similarly dusted. A black streak runs through median rays of caudal fin.

(In life). A blue-black lateral stripe from snout to caudal set in a broad diffuse crimson band, below this the scales are yellowish and at times possess red lunules. Belly white ; above the crimson band is a streak of yellow. The dorsal colouring is olive with green reflections. Fronto-median line yellowish green. The yellow iris has a red rim with a crimson streak through the centre. Pectorals deep orange, the other fins crimson. *P. titteya* is a hardy fish and capable of quick colour transformation.

Distribution. Shady hill streamlets of Ceylon. Ambagaspitiya (Yakvala, W.P.); Wye Estate (Homagama, W.P.); Kirindivella, (W.P.); Udumullai ela (Nambapana, Sab.P); Matugama, (W P) ; Vakvella. (S.P.).

Type. Collected at Ambagaspitiya, September 2nd, 1927. by the writer and sent to the British Museum. Length 26 mm. perforated lateral line scales 3, predorsals 8. I have named this species after the Sinhalese name.

Labeo (Morulius) gadeya sp. n. (Plate XXII)

Local names. *Kalu Gadeya, (S.)—Dark Gadeya*
Loku Gadeya, (S.)—Large Gadeya
Velli Gadeya, (S.)—Sand Gadeya

Fins. P 1·15. V 1·8. D 3·10–12. A 3·5. C 19.

Scales. Chest scales small and become fleshy and rudimentary and disappear as they approach isthmus. Lateral line simple tubes, but in old specimens is represented by pits on body and tubes on tail.

LL 40–42, L tr. $\frac{7\cdot5}{5\cdot5}$; predorsals 17–18, preventrals 30–35, interpectorals 15–18.

A short, thick-set fish. Body depth contained 3–3·5 times in length (without caudal fin). Head without scales and contained 3·85–4 in length. Dorsal profile convex, ventral profile straight. Belly smooth and flat. Tail rounded. Snout large, contained twice in head. Well developed tubercles on snout and cheeks, largest on snout. Rostral fold large, with lateral lobes which are as wide as long. Free lower edge of rostral fold, foliate. One or rarely two pair small barbels within postlabial grooves, usually hidden from view. Maxillary pair equal in length to half diameter of eye, mental pair which are rudimentary or absent are much smaller and completely hidden when present. Eye free, in middle of head length or in its posterior half and contained from 4·8 in young specimens to 7·8 in old ones. Interorbit 2–4 eye diameters. Width of gape 2·2 into head length ; barely reaches front of orbit. Rostral groove continued into postlabial groove which is large, deep and uninterrupted in middle. Lips fleshy with an inner horny fold in upper and lower jaws. Lower lip distinct from lower jaw, and has an anterior and posterior fringe of papillae. The posterior fringe forms two clumps of papillae near angles of mouth above mental barbels. Preorbital 1·5 times as long as eye, triangular with apex toward eye. Suborbitals very narrow. Preopercle reaches far below level of opercle, and is heavily covered with muscle. Height of opercle equals 2 its width. Gill membranes fused to isthmus at level of posterior edge of preopercle. Branchiostegal rays 3, deeply buried in skin and completely overlap each other. Pharyngeal teeth 5.4.2. small.

Fins have their single rays, soft and entire, each branched ray of dorsal and anal possesses fleshy marginal lappets which ensheath the consecutive ray. Pectoral contained 4·3 in entire length, and inserted low down and close to gill slit. Convex on anterior edge, concave posteriorly with pointed tip. This fin is somewhat longer than

ventral and considerably longer than anal and reaches insertion of ventral fin.

Ventral inserted behind origin of dorsal, similar in shape to pectoral and has a fleshy axillary scale. Point of insertion midway between insertion of pectoral and origin of anal; its tip reaches cloaca. Dorsal has no scaly basal sheath, its origin in mid back, base equals its height, equals height of anal, equals 0·8 head length. Upper margin of dorsal straight. Anal short with origin under posterior tip of dorsal, reaches 0·75 of caudal peduncle when depressed. Posterior edge of fin concave. No basal scaly sheath.

Caudal deeply emarginate, longer than head, contained 3·5 in length, in some specimens upper lobe longer than lower lobe. Shortest median rays about 1/3 length of long external rays. Nine scales between anal and caudal fins.

Caudal peduncle has 18 scales round least depth which equals its length. Length of largest specimen examined (without caudal fin) 360 mm.

Colours. (In alcohol). Dark olive dorsally with traces of crimson lunules on lateral scales. Pale green merging into yellow ventrally. A large dark brown blotch at end of caudal peduncle in young specimens.

Fins pale olive in colour.

Pectoral, ventral and anal fins with a dark posterior margin.

(Fresh dead specimen). Dark olive dorsally, crimson lunules on olive green sides, belly white or pale orange shading into white. Dark brown blotch at end of caudal peduncle, absent in old ones. Pectoral, ventral and dorsal fins olive green, caudal and anal deep orange in some adult specimens, olive in others.

This species presents a superficial resemblance to *Labeo potail* (Sykes), but comparison with a specimen from the Indian Museum, Calcutta, shows it to differ in the following respects.

	Labeo gadeya	*Labeo potail*
1.	Head formula 3·85–4.	5.
2.	Tubercles on head large.	Small.
3.	Barbels four or two.	Two.
4.	Free edge of rostrum foliated.	Entire.
5.	At each corner of lower lip a clump of papillae.	No clump of papillae.
6.	Small fleshy scales on chest.	Osseous scales on chest.
7.	Predorsals 17.	21.
8.	L tr. $\frac{7\cdot5}{5\cdot5}$	$\frac{9\cdot5}{5\cdot5}$
9.	Origin of dorsal in mid-back.	Closer to snout than to caudal fin.
10.	Upper margin of dorsal, straight.	Concave.

This fish is adapted for life in flowing water by having its paired fins set on very low to enable it to cling to rocks in order to browse on the algal growth. Its chest scales have been modified in accommodation to this existence. The ventral profile is flat and the rays of the dorsal and anal fins guarded by fleshy marginal lappets which appear to prevent injury to the connecting membrane should the animal be caught sideways by the torrent.

Distribution. Mountain streams :

Matale, Mahavelliganga at Levella (Kandy), 509 metres above sea-level.

I wish to express my thanks to Mr. J. R. Norman of the British Museum for comparing this fish with known species of Labeo in the British Museum Collection ; Dr. Baini Prashad of the Calcutta Museum for permitting me to examine a specimen of *Labeo potail* (Sykes) and to Dr. P. E. Pieris, of the Ceylon Civil Service, for obtaining the five specimens examined.

Type. Collected at Levella, February, 1928, by Dr. P. E. Pieris and sent to the British Museum.

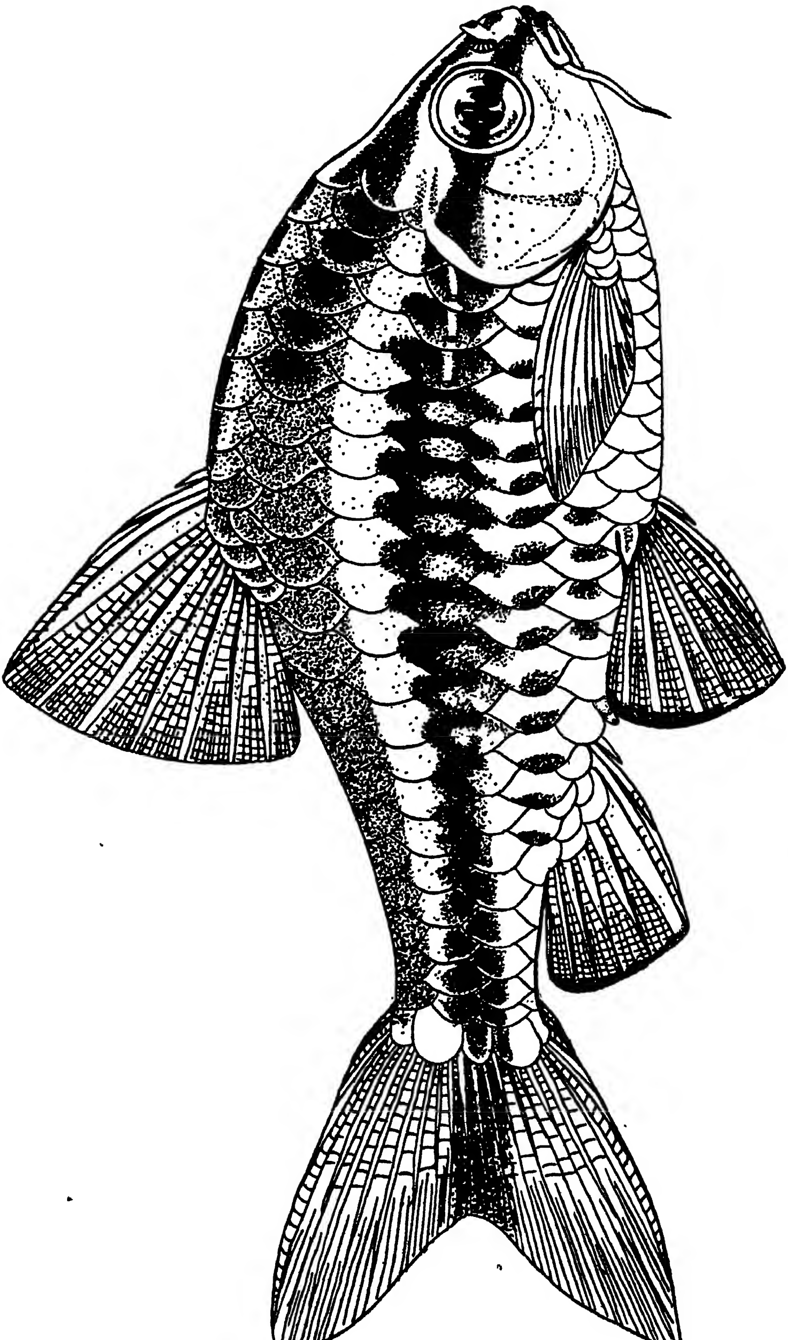
Length (without caudal fin) 330 mm.

Mental barbels absent, head 3·5, eye 7 and placed in posterior half of head. I have designated this species after the Sinhalese name.

Explanation of Plates

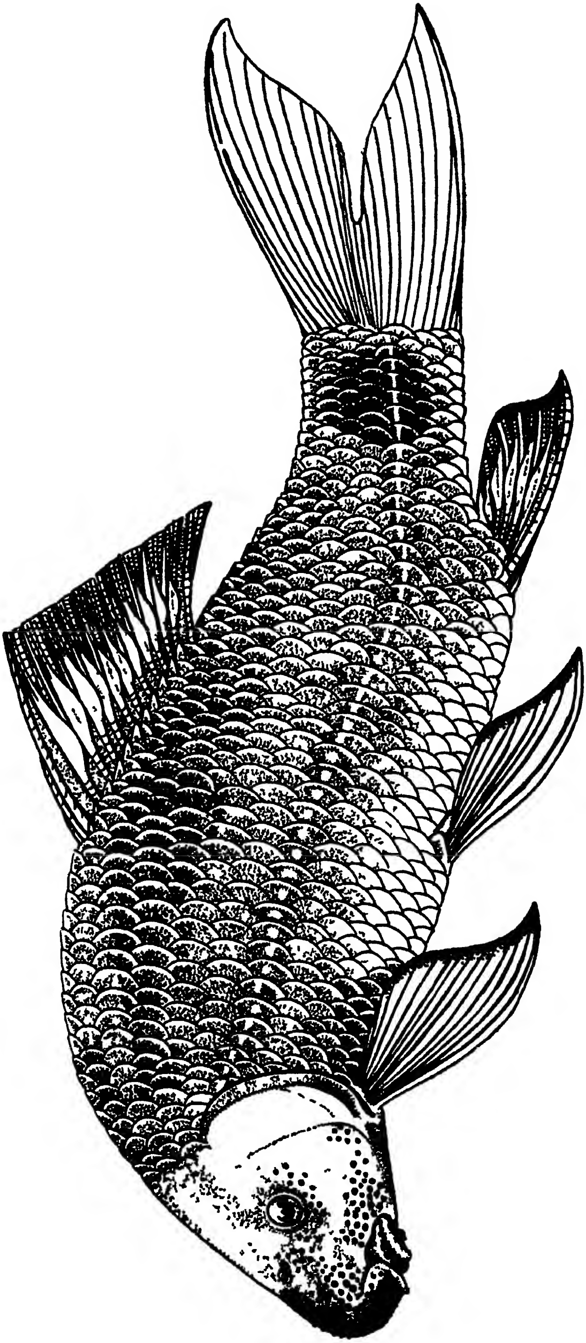
Plate XXI. *Puntius titteya* × 5.

Plate XXII. *Labeo* (*Morulius*) *gadeya* × ⅓.



Puntius titteya Deraniyagala.

P. E. P. Deraniyagala. del.



Labeo (Morulius) gadeya Deraniyagala.

P. E. P. Deraniyagala del

The Labyrinthici of Ceylon

BY

P. E. P. Deraniyagala, M.A. (Cantab), A.M. (Harvard)

2nd Assistant Marine Biologist, Fisheries Department

WITH NINE PLATES

The order Labyrinthici, although represented only by nine species, is the most important group of Ceylon fresh water food fishes. The reader is referred to Weber and Beaufort (1922), and Day (1878–1888), for a complete synonomy of each species. In every description, the colours, shape and proportions were observed in living specimens.

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The order *Labyrinthici* is divisible into three sub-orders *Ophicephaloidea*, *Luciocephaloidea* and *Anabantoidea*. The sub-order Luciocephaloidea, which is not found in Ceylon, occupies an intermediate position and contains several characters from each of the other sub-orders.

Order LABYRINTHICI

Scaly teleosts as dependant on aerial as on branchial respiration. Suprabranchial air chambers present, with or without a respiratory organ inside. Air bladder present or absent, physoclist when present, extending almost to caudal fin. This prolongation may or may not possess a median septum.[1] Four well developed gill arches. Pseudobranchiae absent. Mouth bordered by intermaxillaries. Maxillaries

1. Never bifid.

edentulous, parasphenoid dentigerous. Ventral fins thoracic. Scales cycloid, ctenoid or both.

Sub-order OPHICEPHALOIDEA

Spineless, elongate and sub-cylindrical anteriorly, compressed posteriorly. Head depressed, altering in shape with age, the lower jaw becoming prominent and the interorbital space depressed. Head shields cycloid with concentric marginal rings, are more or less uniform in their arrangement for each species. Body scales cycloid and of medium size covered with numerous striae. Mouth protractile, large. Teeth in close-set cardiform bands interspersed with canines which are present or absent on the vomers and palatines; always absent from the intermaxillaries and always present on the mandibulars. Gill membranes naked, united but free from isthmus. Branchiostegals 5. Two accessary pharyngeal air cavities assist respiration and enable the fishes to withstand rigorous dry conditions for many hours. No suprabranchial organs. Transpiration occurs through the vascular mucous membrane which lines these cavities, the surface of which is increased by the presence of ridges and papillae. These cavities are kept filled with air through the mouth, for which purpose the fishes rise to the surface, and are as dependant on aerial as on branchial respiration and die within a few hours if prevented from access to the surface. Fins spineless, dorsal and anal long, the origin of the former anterior to the origin of the latter by about half the length of the base of the anal or by about one-third its own base. Ventrals thoracic when present. The lateral line descends once in a step-like gradation. Two pyloric caeca always present.[2]

Caudal vertebrae with ribs which enclose a single prolongation of the air bladder which extends nearly to caudal fin. Only the last 3 or 4 caudal vertebrae possess haemal arches.

They are nest building fishes, clearing a space in shallow water where the eggs are laid. These eggs float at the surface and possess a single large oil globule. The parents guard the eggs and fry. They are predaceous in their feeding habits and are only found in fresh water and are said to take no food when guarding the eggs. The fishes sun themselves at the surface during the day and at night venture into very shallow water in quest of prey, and at times travel from pond to pond along the damp ground progressing with head raised, by the means of a series of twists and jumps. The fry live at the surface in shallow water and are useful destroyers of mosquito larvae. These fishes possess a considerable

2. Günther, Day and Herre report that *Channa* has no pyloric *caeca*. I have dissected several specimens of *C. orientalis* from different localities and have always found two well developed pyloric caeca, one about half the length of the stomach, the other as long as or longer than the stomach.

range of colour change and speedily alter their hue according to their surroundings or mental condition.

Cephalic shields. The scales of the head differ from those on the rest of the body in their greater strength and size and by being less imbricate. In addition they are marked with concentric circles, whereas the body scales have numerous striae. Hence they may be regarded as shields rather than scales.

In view of the difficulty of identifying decolourized spirit specimens the writer suggests that the grouping and position of the head shields provides an alternate and accurate method of fixing the identity of the Ceylon species. For this purpose an imaginary line is drawn from each posterior nostril through the sense pit on the cephalic shield behind it. (Plate XXIII, fig. 1). This shield is the supranasal (S.N.). This line intersects its fellow at a sense pit on the frontal shield (F.) which is interorbital in position.

Each line when produced finishes at the sense pit of the second supraocular (S.O.) above the eye of the opposite side. Next the sense pits along the posterior edge of the preopercle are followed upward until they finish on top of the head. The last pit is joined to its fellow on the opposite side and the shield posterior to this line is the basal (B). Each supranasal shield (S.N.) touches the frontal (F.) with its hind edge. Between the supranasals lie the internasals (I.N.) in front of which are the prenasals (P.N.).

A more or less regular rosette of shields is located in the interorbital space in some, in the postorbital space in others. In the former case the frontal (F.) is in the centre, in the latter, the large polygonal median shield (M.) which has six marginals touching it. Of these only one touches two sides of (M.) and may be termed the arrow-head shield (A.) from its shape.

The figures on Plate XXIII were drawn from actual specimens. The rosette in each case is denoted by thick lines. The figures include only that portion of the head which is anterior to the preopercles which are marked. The opercles are omitted.

Cephalic sense pits. The shape and structure of the sense pits on the head, especially those on the throat and on the posterior edge of the preopercle are of some help in identifying the Ophicephalidae. The development of these pits in the two larger species ***Ophicephalus marulius*** and ***O. striatus*** undergoes five transitional stages during the growth of the fish from larva to adult.

In the larval fish they are in the primitive state as single conspicuous holes in the bone, opening into a sensory canal which is plainly discernible. Later on, each of these holes develops a transverse septum and the two

holes so formed move some distance from each other. Towards the end of this stage, the fish develops an ocellus according to the species, either on the dorsal or caudal fin and now an external membrane covers the two pits which open out in a single row of four to six minute pores which are in a straight line. While the fish is still in the ocellus stage a second row of pores appears and runs nearly parallel to the first row. Finally, in the adult stage the entire covering membrane is perforated by numerous pores giving it a sieve-like appearance. The double pit stage is exposed on dissecting off this membrane.

The smaller Ophicephalidae such as *Channa orientalis*, *O. punctatus* and *O. gachua* do not advance beyond the single pit stage, but the two larger species *O. marulius* and *O. striatus* pass through the full process from the single *primitive pit* to the *sieve stage*.

This sieve development appears to be a filtering device to keep out mud. In the smaller species the pits are sufficiently small in themselves to filter solid particles. However, they have the pits partially occluded by an external membrane which develops with maturity and keeps the size of the orifice constant in spite of the increase of the fish in age and dimensions.

Key to species of Ophicephalus [1]

A. Cephalic sense pits multiple, prenasals present.
   (*a*) 1, 2 or 3 internasals, 2 or 3 scales between rosette and basal .... *O. marulius*.
   (*b*) 1 internasal, 4 or 5 scales between rosette and basal .... *O. striatus*.

B. Cephalic sense pits single, prenasals absent.
   (*a*) 2 scales between rosette and basal .... *O. punctatus*.
   (*b*) Rosette touches basal .... *O. gachua*.

Genus **Ophiocephalus** Bloch.

Elongate, cylindrical fishes with cycloid scales. Fins spineless, unpaired ones long. Ventrals present, gape wide, teeth on palate well developed. Canines on lower jaw.

1. This is the original spelling by Bloch, but called *Ophiocephalus* by most subsequent authors,

Ophiocephalus marulius Ham. Buch. (Plates XXIII, XXIV)

O. marulius, Ham. Buch. Fishes of Ganges, 1822.

Local names. *Gan ara*, (*S.*)[1]—*River ara*, (*W.P.*),[2] (*S.P.*), (*C.P.*)
Ara, (*S.*)— (*W.P.*), (*Sab.*)
Kalu maha,(*S.*)—*Black fish*, *Veyangoda*, *Gampa ha*, (*W.P.*)
Iru viral, (*T.*)—

Fins. P 16–18. V 6. D 48–51. A 32. C 15.

Scales.[3] LL 16–21·2· 40–44, (a) L tr. $\frac{5\cdot5}{11\cdot5}$; (b) L tr. $\frac{7\cdot5}{9\cdot5\text{–}10\cdot5}$

Predorsals 7–8, preventrals 19–20, scales between insertions of pectoral and ventral fins 7–11.

Scales from eye to posterior edge of preopercle 7–8.

Scales from anterior to posterior edges of opercle 3–4.

Measurements. Head 3·1–3·5, eye 5·6–10, interorbit 1·5–3·5, snout 1–1·5. Length of gape 2·5 in head, width of gape 2·1–2·25 in head. Depth of body 4·8–6. Lateral line descends two rows of scales underneath the 12th–14th dorsal ray. Pectoral fin 5–5·8 in entire length and equals, postorbital part of head. Ventral fin 7·5 in entire length and somewhat longer than length of eye and snout. Caudal fin 4·25–5·5 in entire length. Rather elongate enlarging gradually to its greatest width with an elliptical posterior edge. Dorsal fin longer than anal by a postorbital head length or by half base of anal fin. Base of dorsal extends behind the end of the base of anal.

This fish is slender when young but rather thick set when fully grown and is the largest and rarest Ceylon Ophicephalid. Attains to about 800 mm. in length and a weight of about 2,800 grs. The gape is horizontal and extends beyond the eye. Frontal cephalic shield bifurcated' anteriorly and usually touching two internasals, rarely three, or one. Each of these seldom has more than one prenasal. Rosette irregular with frontal shield in centre and seven marginals ; two to three

1. Throughout this paper (S) = Sinhalese, (T) = Tamil
2. W.P = Western Province ; S P. = Southern Province.
C.P. = Central Province , Sab. = Sabaragamuwa.
N.C.P. = North-Central Province ; N.W.P. = North-Western Province.
E.P = Eastern Province ; N.P. = Northern Province.
3. The number of perforate scales in the lateral line (LL) are signified in three figures The number of scales this line descends is denoted by the middle figure, thus 15.2 29. When the line dips two scales after running in a straight line for 15 scales. In view of this descent of the lateral line it has been found necessary to give two transverse scale readings

(*a*) *L. tr.* is from the ventral fin to the dorsal and is anterior to the dip of the lateral line. (*b*) *L. tr.* is from the anal to the dorsal fin and is posterior to this dip. Predorsal scales are counted from behind the basal shield of the head (Vide Cephalic shields page 8) down to the origin of the dorsal fin. The scales between the ventrals are also included in reckoning the preventral scales.

Measurements are as follows :—

Entire length = tip of snout to base of caudal fin exclusive of fin.

Head = $\frac{\text{entire length}}{\text{head length.}}$; .... Snout = $\frac{\text{snout}}{\text{eye.}}$

Eye = $\frac{\text{head}}{\text{eye}}$; Interorbit = $\frac{\text{interorbit}}{\text{eye}}$

shields between rosette and basal shield. This basal shield in some cases, contains a sense pit. (Plate XXIII, fig. 2). Cephalic shields smooth in adult.

Teeth. In cardiform patches on mandibulars, intermaxillaries, vomerines and palatines. Each mandibular has 7–18 canines directed backwards behind a single row of villiform teeth which deepen to 5 or 6 rows at the symphysis. Each vomerine has 3 rows of villiform teeth. No canines on palatines. Intermaxillaries have 2 or 3 caninoid teeth near symphysis. Parasphenoids a pear shaped cluster.

Colours. The colours vary and the fish can completely change its hue in a few minutes. This feature is probably responsible for the great confusion in the synonomy for this species. The general colours are pale olive (dorsal), bright brassy yellow (lateral), dirty yellow (ventral) merging into grey on the throat. A diffuse dark violet lateral band extends from the eye to the posterior tip of the caudal fin. This band is crossed by five or six large rhomboidal patches which extend a short distance into the dorsal fin. There are one or two dark violet bands on top of the head. The dark violet lateral band is capable of great expansion and when dilated in the adult gives it an almost total dark violet appearance which has earned for it the name of "Kalu maha"—black fish. This darkening occurs chiefly when the fish is active or stimulated by food and at such times even the belly is dark while only the gill membranes remain white. Pectoral, dorsal, anal and caudal fins vary in colour from a pale olive to a dark violet with numerous white spots on the last three fins. Ventrals a dirty white. A white edged ocellus somewhat smaller than the orbit is at times present on the upper half of the base of the caudal fin, but is usually absent in specimens longer than 260 mm. The white spots on the fins are much smaller and some outline the brassy yellow lateral areas and are also present over the lower portion of the transverse dark marks. These white spots can be repressed at will. The throat scales are white with a grey or dark violet centre. The eye is deep orange with a dark vertical diameter.

In the very young fish there is a bright yellow lateral line[1] running from the orbit to the caudal fin which has a large bright orange spot in its upper half. This spot later assumes a dark centre and develops into an ocellus and at this stage about five or six dark cross bands appear dorsally to the lateral line, while brown dots appear on the dorsal and anal fins and about five dark vertical bands on the caudal; the ventral scales assume a grey centre. Later in life the yellow lateral stripe

1. According to Hamid Khan in Indian specimens the yellow lateral bands appear on fry 26 mm. long.

disappears and is replaced by the dark violet lateral band, while the orange edged ocellus becomes white edged and usually disappears in the adult. The pectorals, ventrals and anal are yellow, dorsal and caudal dark.

Sense pits. The development of the pit and length of fish are as follows :—

(1) Double pit stage when 98 mm. long. A yellow lateral line and orange caudal ocellus.
(2) Single row stage 165 mm. long. Yellow line absent, ocellus present.
(3) Double row stage when 230 mm. long.
(4) Sieve stage beyond 230 mm.

As its name "Gan ara" implies it is found chiefly in the deeper streams and rivers and is much prized by the Sinhalese as a pet owing to its rarity and large size. It is kept in village bathing wells where it soon becomes so tame that it will allow itself to be stroked and when feeding delights its owners by its quick colour transformations as it races after its prey which it seizes with resounding snaps. It is a voracious but very discriminative feeder, usually only accepting living food, but tame specimens have at times been trained by the villagers to accept a diet of dried prawns. At Vakvella (S.P.) large specimens are reported to leap out of the water and seize snakes which lie basking on branches overhanging the river and for this reason its flesh is not popular with the local villagers. It is a pugnacious animal and two adults of the same sex cannot be kept together.

The usual method of capture is by laying night lines baited with a living frog or Ophicephalid fish, but large specimens are also shot from the bank as they bask at the surface or are struck with a barbed fish sword.

Reproduction. In Ceylon the breeding season is said to range from April till June. A specimen 98 mm. long with orange lateral line and orange edged caudal ocellus was taken at Vakvella (S.P.) on August 20th, 1926, and was probably 12 weeks old.

A female and young noticed at Vakvella, July, 1928. A female 635 mm. long from Kalutara on September 17, 1928, had mature ova.

Hamid Khan, describing the habits of *O. marulius* from the Punjab where it is common, says that both parents make a nest by biting off pieces of weed. The eggs are 2 mm. in diameter, orange in colour, with a single oil globule in the yolk and a gelatinous cover. They float at the surface and hatch in 54 hours at a temperature of 61–79 F. and in 30 hours at 83–92 F. The fry, which are 4·5–5 mm. long on hatching, are zealously guarded by both parents, and in one case a parent fish was seen to leap out of the water after a marauding kingfisher. The young

attain to a length of 26 mm. when 19–21 days old and 90 mm. when 11 weeks.

Distribution.[1] Found in inland waters up to an elevation of 509 metres above sea-level.

Levella, Peradeniya, (C.P.).
Veyangoda, Yakvala, Athanagallu Oya!, Kelaniya, Kaluganga!, (W.P.)
Maha Oya, Deduru Oya, Batuluoya!, (N.W.P.)
Anuradhapura, (N.C.P.)
Pelmadulla, Kahavatta!, (Sab.)
Ginganga, Vakvella, (S.P.)!
Ceylon, India, China, Sumatra, Borneo.

Ophiocephalus striatus Bloch. (Plates XXIII, XXV)

O. striatus Bloch, Ausland Fische VII, 1793.

Local names. *Luhula, (S.)*
[2] *Hal path maha (S.) Hal leaf fish.*
Viral (T.)

Fins. P 15–17. V 6. D 42–46. A 25–28. C 15.

Scales. LL 15–18 · 2–3 · 39–42.

(*a*) L tr $\frac{4\cdot5\text{–}6\cdot5}{9\cdot5\text{–}13\cdot5}$; (*b*) L tr. $\frac{5\cdot5\text{–}7\cdot5}{9\cdot5\text{–}10\cdot5}$

Predorsals 8–10, preventrals 15–18, scales between insertions of pectoral and ventral fins 4–6.

Scales from eye to posterior edge of preopercle 8–11.

Scales from anterior to posterior edges of opercle 4–5.

Measurements. Head 2·7–3·9, eye 4–10, interorbit 1–2·5, snout 1·8–2, length of gape 2·25–2·5 in head, width of gape 2·5–2·7 in head. Depth of body 4·8–6.

Lateral line descends two or three rows underneath the 12th or 13th dorsal ray. In some fishes it is partially interrupted and occasionally there is a second lateral line which is incomplete. Pectoral fin 1·8–2 in head. Ventral fin somewhat longer than eye and snout.

Caudal fin 5–5·4 in entire length. This fin enlarges rather rapidly to its greatest width and has its posterior margin rounded into a semi-circle. Dorsal ahead of anal by 16–19 rays or by half the length of the base of anal.

Base of dorsal ends behind base of anal. This fish is elongate and reaches 680 mm. in length, the gape which is slightly oblique extends well beyond the orbit in the adult. Frontal cephalic shield sometimes bifurcated posteriorly, touching the single internasal which has two rows consisting of three small prenasals each. Rosette irregular with frontal

1. Places where the species was abundant are denoted !
2. Hal—*Vateria acuminata.*

shield in centre and with 6–8 marginals. Four or five transverse series of shields between rosette and basal shield. (Plate XXIII, fig. 3). Cephalic shields rugose in adult.

Teeth. In cardiform patches on mandibulars, intermaxillaries, vomerines and palatines. Each mandibular has 4–7 upright canines behind a single row of villiform teeth which deepen to six rows at symphysis. The anterior mandibular canines are set at a distance from the symphysis. Vomerines are villiform patches of teeth.

Palatines, villiform, in two or three rows. Intermaxillaries villiform, pluriserial. Pharyngeal teeth, strong canines in ovoid patches. A band of teeth on parasphenoid in three longitudinal rows of 20 each tapering posteriorly to a single row.

Colours. The general colours vary with the nature of the water, and range from olive green to dark brown dorsally, white to deep orange laterally with white throat and belly which are more or less mottled with irregular streaks and spots of brown. The top of the head has a few dark spots with a brown patch under the eye which extends to the maxillary and bends at right angles running longitudinally along the maxillary across the white or orange ventral colouration until it reaches the posterior edge of the preopercle where it disappears or is continued to the hind edge of the opercle as a row of dots. The eye colour changes under light and dark conditions from red to yellow and when the fish is resting the lower half of the eye is suffused with brown. The body has about fifteen transverse W-shaped dark bands opening anteriorly which are wider than the interspaces. The dorsal and anal fins are olive with a more or less distinct narrow longitudinal band of white or orange along the base of each. The first and fourth limbs of the "W" break up these bands of the dorsal and anal fins respectively into interspaces and in the dorsal the last two stripes which are darker than the others combine with the interspace to form a pseudo-ocellus in the young of 40 mm. in length which at times persists in the adult. The anal fin has a light coloured external margin. The pectoral is a uniform olive or brown, the ventrals white with four transverse rows of brown dots and there are three transverse stripes of white or orange across the base of the caudal fin which is olive or brown.

The newly hatched larva is transparent, but black pigment appears in the eye within 24 hours. Later the entire animal becomes a deep orange which is most intense on the head and along the lateral line. This colouration persists until the animal is 15 mm. long when a greenish tint appears dorsally and a shiny white spot which can be repressed at will is seen on the vertex as in the *Cyprinodontidae.* The ventral portion of the belly and tail is a dark grey, which colour extends to the posterior

tips of the lower caudal rays. With growth the orange pigment gradually fades and when the fish is 25 mm. long this pigment only persists as a diffuse lateral stripe which is best defined on the tail. The lower half of the eye is white, the upper portion orange, the belly is white while the lower quarter of the tail is dark grey. The fins are a pale yellow with dark margins to the dorsal and anal. Later, when 40 mm. long, dark stripes differentiate out and a pseudo-ocellus forms at the posterior edge of the dorsal fin. *Ophicephalus striatus* is unable to change its colour so completely or as rapidly as *O. marulius*, but displays a great range of colour variation caused chiefly by the nature of the water in which it dwells. Specimens taken from rivers and flowing water have white or pale green bellies with sparsely scattered spots. The head and back are olive green. Specimens from swamps or ponds full of decaying vegetation have yellow or bright orange sides and white belly with more numerous spots and streaks and are dark brown dorsally. The cornea also is thickened and of a bluish tint. Specimens taken in still water having access to the sea possess a distinct pink tinge on their otherwise white sides and bellies, while the white scales bordering the dark bands are a pale blue. The back is olive. The eye colour ranges from red to yellow and is more or less suffused with brown.

Sense pits. The stage of the pit and the length of the fish are as follows :—

(1) Primitive pit stage when 13–28 mm. long.
(2) Double pit stage when 57–61 mm. long, ocellus on dorsal.
(3) Single row stage when 118–140 mm. long, ocellus present.
(4) Double row stage when 125–182 mm. long, ocellus present.
(5) Sieve stage when 235 mm. and over.

O. striatus may be ranked as one of the most important fresh-water food fishes of Ceylon. Although it does not usually exceed 360 mm. in length, it occurs in large numbers being very hardy and prolific and the flesh is free from the numerous intermuscular bones of the *Cyprinidae*, which are equally abundant. In some districts, such as the North-Central Province, the villager depends on it for existence when his crops fail owing to the drought, which however compensates him with fish by drying up the tanks.

The "Luhula" when dried in the sun is much esteemed, but the supply is limited and, with the extension of the railway, fresh fish finds its way to other places. Willey, writing in 1909, stated that at Topaveva this fish was split, cleaned and dried over a fire. Later it was sold to traders from Matale at Rs. 7 per bundle of 100 fish.

The flesh of this fish is prescribed as a diet for invalids owing to its digestability and freedom from cloying fat, while the raw flesh tied on

to ulcers is said by the villagers to attract the maggots out of them. *O. striatus* varies in flavour with the water it inhabits, those from flowing water being much superior to fishes taken from swamps or ponds.

There are various devices for capturing this fish. Hook and line with live bait is not so destructive as the "Karak geddiya," a cone-shaped wicker basket open at both ends. The fisherman walks about in the water pushing the large end into the mud and when he feels a fish beating against the sides he extracts it from the upper opening. Another method is to slash the fishes with a sword after attracting them with a light. At Kantalai tank (E.P.) and other places they are shot while basking in the shallows in a depth of a few centimetres of water. The fish makes a dash for deeper water on the approach of the man, but in the shallow water the top of its back is exposed and it is shot. Willey stated that the Veddahs near Minneriya employ a narrow wicker cone which is set in the runnels to and from the nests of these fishes and the parent fish once it enters the cone cannot turn round and is caught.

Reproduction. Oviposition seems to occur several times in the year as newly hatched young have been observed at various seasons. The amber coloured eggs which are 1·25 mm. in diameter are rendered buoyant by the presence of a single large oil globule in the yolk, and float at the surface in a clearing among the weeds. The parent fish mounts guard and has entrance and exit runnels to the nest. Hatching is said to occur from 24 hours to 3 days after oviposition. The newly hatched larvae, according to Willey, are 3·5 mm. long and in two days pigmentation occurs, pectoral fins arise, the mouth opens and branchial respiration commences. The fry are coloured a bright orange and keep together, rising to the surface or sinking under water simultaneously until the fish are about twenty-five days old when they act less in unison and when sixty-three days old the fry studied by Willey in 1910 were 17 mm. long and had commenced to hide in the mud of the aquarium.

Young *O. striatus* showing red colouration were obtained from the following places at the dates mentioned —

Date	*Locality*	*Length of fish*
Aug. 6th, 1926	Katupota, (N.W.P.)	16 mm.
July, 1926	Kopa kulam tank, Anuradhapura, (N.C.P.)	28 mm.
Dec. 8th, 1927	Murungan, (N.W.P.)	20 mm.
May 13th, 1927	Pinketti veva, Batuluoya, (N.W.P.)	41 mm.
April 4th, 1927	Vakvella, (S.P.)	25 mm.
April 24th, 1927	Kehelvattai ella, Moratuwa, (W.P.)	17 mm.
March 24th, 1928	Yakvala, (W.P.)	16 mm.

Distribution. Fresh water ponds, streams, and tanks.

Colombo!, Dehivala Bolgoda!, Kalutara Baddurueliya, Kelaniya!, Yakvala!, Veyangoda!, Kirindivella, (W.P.).

Batuluoya!, Chilaw!, Puttalam, Thatta veva, Nikkaveratiya, Katupota, (N.W.P.)

Anuradhapura!, Rambeva!, Madavachchiya!, Nochchiyagama!, Minneriya!, (N.C.P.)

Murungan, Vannivillankulam!, Tunukai, (N.P.)

Dedduva Lake, Vakvella!, Matara!, (S.P.)

Kantalai Tank!, Kumbukkan Oya!, Kumana!, (E.P.)

Pelmadulla, Kahavatta, Kegalla, (Sab. P.)

Although common everywhere in the low-country it is absent from the Tissamaharama tanks (S.P.) for some unknown cause, but occurs at Matara (S.P.) and at Kumana (E.P.) which are close by. This fish is found in the low-country up to a height of 119·5 metres above sea-level.

Ceylon, India, Burma, Siam, Penang, Malay Peninsula, Malay Archipelago, South China, and introduced by man to the Philippines and Hawaiian Islands.

Ophicephalus punctatus Bloch. (Plates XXIII, XXVI)

O. punctatus Bloch, Ausland Fische 7, 1794.

Local names. *Muda ara*, (*S.*)—*Mud ara*, (*N.W.P.*), (*W.P.*), (*S.P.*), (*C.P.*)
Mada kannaya (*S.*)—*Mud kannaya*, (*W.P.*)
Mada kariya (*S.*)—(*W.P.*)
Madaya, (*S.*)—(*W.P.*)
Korruvai. (*T.*)

Fins. P 15–18. V 6. D 29–30. A 20–22. C 13.

Scales. LL 13–15·I·21–24 (a) L tr. $\frac{4\cdot5}{7\cdot5}$; (b) L tr. $\frac{5\cdot5}{7\cdot5}$

Predorsals 5, preventrals 10, scales between insertions of pectoral and ventral fins 3, scales from eye to posterior edge of preopercle 5, scales from anterior to posterior edges of opercle 2–3.

Measurements. Head 2·9–3, eye 6·5–8·5, interorbit 1·4–2, snout 1–2, length of gape 2·5–3 in head, width of gape 3–3·2 in head.

Depth of body 4–6 in entire length. Lateral line descends one scale under 11th–13th dorsal ray. In some specimens this line is interrupted and occasionally there is a second lateral line which is incomplete.

Pectoral fin 4·75–5·1 in entire length, reaches anal and is as long as half the head length.

Ventral fins barely reach anal.

Caudal fin 4·2–5 in entire length, is broad and well rounded, nearly circular in outline.

Dorsal ahead of anal by 9–10 rays or by about half the base of anal fin. Its base ends behind that of anal.

A very thick set fish with a very oblique gape which does not extend behind the orbit. The head is triangular and tapers into a pointed snout. The fish attains a length of 200 mm.

Sense pits of head single. Frontal shield, which does not touch the single internasal, is in centre of rosette. Prenasals absent. Rosette regular, elliptical and interorbital, with two transverse rows of shields between itself and the basal (Plate XXIII, fig. 4).

Teeth. Cardiform patches. Each mandibular has 3–6 canines behind a single row of villiform teeth which deepens to 5 or 6 at symphysis. Vomerines, two rows of villiform teeth. Palatines villiform in two or three rows. Intermaxillaries pluriserial, villiform. Pharyngeal teeth canines in ovoid patches. One or two teeth on parasphenoid.

Colours. (*Adult.*) The colours are less affected by the nature of the water than in the two previous species. Dorsally it is olive with greenish yellow sides and white, pale green or yellow ventral colouration. Occasionally the throat is bluish green. In some specimens there are numerous minute black dots on the sides of the head and body. One well defined dark brown stripe runs from mid eye to the top corner of the opercle, another descends from the eye to the corner of the mouth and extends across the middle of preopercle and the opercle. The eye is orange with a vertical brown diameter. Two or three pairs of blotches which converge anterioriy lie on top of the postorbital part of the head and there are four black dots on the interorbital space.

A well defined black shoulder mark exists above the pectoral fin. Six or seven dark transverse triangular bands descend from the base of the dorsal to the lateral line on which they have their bases. These are somewhat narrower than the interspaces. Ventrally there are ten dark streaks. The fins range from pale yellow to dark olive and have a light border. The dorsal is marked longitudinally with four or five rows of spots, of which the lowest series are the largest. The anal has three or four such rows. The caudal has four or five indistinct dark transverse bands with a light olive transverse band near the base. Pectorals with five transverse bands, the white ventrals are at times dusted with black.

(*The young*), when fully pigmented, possess three yellow stripes on a chocolate background which is very light ventrally. On each side there is a golden lateral stripe as wide as the orbit and extending from the snout, through the eye to the middle of the caudal fin. A median yellow stripe runs from the snout along the base of the dorsal fin. This colouration persists up to a length of 13 mm. after which the median stripe on the head separates from that portion which is along the base

of the dorsal fin. The body scales now possess dark spots, about six transverse dark bands appear on the body and cut up the lateral line, and there are three dark bands on the caudal fin. When the fish is 19·5 mm. long, the fronto-median yellow line which is spindle shaped commences to shorten and later disappears, but the yellow lateral lines persist for some time after the fish assumes its adult colouration and have been seen on specimens 70 mm. long.

Sense pits. Single at all stages of growth.

Economically *O. punctatus* is the second most important Ophicephalid and is common in many fish markets throughout the greater part of the year. It is taken by hook, Karak geddiya, cast nets and baling water out of ponds.

Reproduction. *O. punctatus* probably breeds several times during the year as the striped young have been collected at different seasons.

The amber coloured ova are 1·2 mm. in diameter and contain a single large oil globule in the yolk which enables them to float at the surface.

The eggs are laid in shallow water where there is plenty of food. No nest is constructed and the young of Indian specimens, according to Sundara Raj, hatch in 24 hours. The fry measure 3·25 mm. in length and are 5 mm. long on the fourth day when they assume their chocolate and gold colouration.

The striped fry were obtained from the following localities:—

Locality	*Date*
Yakvala, (W.P.)	March 24th, 1928
" "	May 2nd, 1928
Batuluoya, (N.W.P.)	May 12th, 1927
" "	June 6th, 1926
Kalpitiya, (N.W.P.)	June 10th, 1926
Vakvella, (S.P.)	Aug. 21st, 1926
Bellana, (W.P.)	April 1908

Distribution. This fish is plentiful in the larger ponds and tanks of the Low-country but is rarely found in flowing water.

Colombo !, Dehivala, Athidiya, Kalutara, Yakvala, Veyangoda, Kelaniya, Bolgoda !, Baduru Eliya, Negombo!, (W.P.)

Batuluoya !, Chilaw !, Katupota, Kurunegala, (N.W.P.)

Bentota, Galle !, Matara, Tissamaharama !, (S.P.)

Murungan !, Jaffna, (N.P.)

Anuradhapura !, Rambeva, Medavachchiya !, Nochchiyagama, Minneriya !, (N.C.P.)

Kantalai !, (E.P.)

Ceylon, India, Burma, Java, Singapore.

Ophicephalus gachua Ham. Buch. (Plate XXIII)

O. gachua Hamilton Buchanan, Fishes of Ganges, 1822.

Local names. *Parandel kannaya*, (*S.*)—*Water weed kannaya*
Para korruvai, (*T.*) —*Pariah korruvai*

Fins. P 14–15. V 6. D 31–35. A 20–23. C 13–14.

Scales. LL 10–12·I·28–32.

$$\text{(a) L tr.}\ \frac{4\cdot 5}{7\cdot 5}\quad \text{(b) L tr.}\ \frac{5\cdot 5\text{–}6\cdot 5}{6\cdot 5\text{–}7\cdot 5}$$

Predorsals 5–6, preventrals 9–12, scales between insertions of pectoral and ventral fins 3–5, commonly 4. Scales from eye to posterior edge of preopercle 5–6, scales from anterior to posterior edges of opercle 2–3.

Measurements. Head 2·9–3·25, eye 4·8, interorbit 1–2·5, snout 1–1·5 orbits. Length of gape 2·5–2·9 in head, width of gape 2·7–3 in head.

Depth of body 5–6·5 in entire length. Lateral line descends under 7–10 dorsal ray. Pectoral fin reaches anal and is equal to postorbital part of head or is contained 4·2–5 in entire length. Ventrals behind pectorals, do not reach anal. Caudal 3·6–5 in length. This fin is broad and inclined to be elliptical along its vertical axis in the living fish. Dorsal ahead of anal by 9–12 rays or by half base of anal or about one-third base of dorsal. An elongate fish with a rather oblique gape which does not extend beyond the posterior edge of orbit. *O. gachua* is the smallest member of the genus *Ophicephalus* and rarely exceeds a length of 156 mm.

Sense pits of head single. Frontal shield touches the single inter-nasal anteriorly and the cephalic rosette posteriorly. Prenasals absent. Rosette touches the frontal and basal shields, is regular, circular and consists of the median shield surrounded by 6 marginals. Both frontal and basal shields are triangular or pentagonal in shape. (Plate XXIII, figs. 4 and 5).

Teeth. Cardiform bands on intermaxillaries, palatines and mandibulars. Each mandibular has a single row of 13–20 close-set canines behind a single row of villiform teeth which deepens into about 7 rows at symphysis. Vomerines consist of six canines on each side behind a

single villiform row. Palatines have 12 caninoid teeth on each side in a single row behind a single row of villiform teeth. Intermaxillaries villiform, pluriserial bands. Pharyngeals canine, in ovoid patches. Teeth on parasphenoid a few or none.

Colours. Specimens from ponds full of decaying vegetation are very dark with red margins to their fins, whereas fishes from ponds with a sandy bottom are light in colour with pale orange margins to their fins.

As in *O. striatus*, this species exhibits the dark W-shaped transverse bands which are about twice as broad as their interspaces and show best on young specimens of about 50 mm. in length. Dorsally the colour varies from a light cinnamon to a very dark brown which is almost black. The second limbs of the "W" cross the back in 8–12 dark stripes which fuse with each other on reaching the lateral line and extend ventrally nearly up to the base of the anal fin.

These stripes are intersected by four narrow longitudinal streaks which run on either side of the base of the dorsal fin. Belly white, throat a pale bluish green. A dark lateral stripe extends from the snout through the eye to opercle, while another runs from the anterior nostril along the maxillary border into the light ventral colouration and along the ventral margin of the preopercle. There are four diffuse dark blotches on the postorbital portion of the top of the head, occasionally a series of minute black dots are present on the sides of the head and body. The eyes are orange with a brown outer rim. The dorsal fin has two upper and lower longitudinal pale olive brown bands separated from each other by a bluish green band. The outer margin is a deep orange or red and the first limbs of the "W" bands enter the basal portion of the fin and in young specimens extend to the outer margin.

Anal bluish green indistinctly crossed by the 4th limbs of the W-shaped bands. There is a greyish brown outer longitudinal stripe bordered externally by an orange or red marginal stripe, while the distal tips of the fin rays are white. Pectorals orange with six dark transverse stripes which are as wide or wider than the interspaces. Ventrals a uniform pale yellow. Caudal with a light-coloured transverse band at its base and with about 8 broad transverse dark bands, external margin orange or red.

The young specimens are a pale reddish yellow dorsally with a deeper diffuse orange lateral streak from snout to caudal fin, extending through upper half of orbit. Lower half of animal, including lower half of eye, a dark grey. Vertex pigmented with black. Fins pale yellow. Later, after the fish attains complete colouration and is about 23 mm. long an ocellus with an orange rim, which is about twice as large as the

eye, often appears on the last five dorsal rays and persists until the fish is about 44–56 mm. long, occasionally there are two such ocelli one behind the other. The proportions of ocellated to non-ocellated young appears to be 1 : 1·557 as seen from the following tables.

Specimens from Diyatalawa, August, 1926.

Ocellus absent		*Ocellus present.*	
Length in mm.	*Numbers*	*Length in mm.*	*Numbers*
22	1	26	3
27	3	30	3
28	2	31	3
29	4	32	2
30	4	34	2
31	2	35	1
32	3	38	1
35	1		
36	3		
38	1		

Ratio of ocellated to non-ocellated specimens is 1· 1·66.

Specimens from Mankulam, March, 1928.

Ocellus absent		*Ocellus present*	
Length in mm.	*Numbers*	*Length in mm.*	*Numbers*
34	1	36	2
36	2	38	1
38	1	40	4
44	1	41	1
45	1	42	1
46	1	45	1
49	1	56	1
50	1		
51	2		
53	1		
54	2		
56	2		

Ratio of ocellated to non-ocellated specimens is 1 : 1·454.

A bleached specimen of *Ophicephalus gachua* about 100 mm. long was obtained from Yakvala, September 18th, 1928. It had evidently been depigmented by dwelling in a stream which travels some distance under a number of large rocks. Its eyes were black, but the entire

body was orange yellow with a few contracted melanophores on body, but not on fins which had a few red vertical bands. After two weeks in a glass tank it assumed normal pigmentation on the sides, at which stage the specimen was lost.

Sense pits. Single at all stages of growth.

Ophicephalus gachua flourishes in ponds rendered so stagnant as to prove toxic to most fishes. The swarms of tadpoles and mosquito larvae which thrive in these ponds supply food for the adults and fry respectively. The fish is very hardy and exceedingly active on land, progressing by a series of leaps. It propels itself into the air by bending its body, planting its tail on the ground and straightening itself with a jerk, and it is a common sight to find these fishes crossing over land while the pond they inhabit is baled dry by villagers in search of fish. On account of its hardiness and the ease with which it is captured it is a favourite live bait for its larger relatives and the part it plays in the capture of the giant *O. marulius* reminds one of the old rhyme " Big fleas have little fleas, etc.," as it is used to capture *O. striatus* which is in turn used as bait for *O. marulius.*

The fisherman inserts the hook into its back without injuring the air bladder and fastens the float close to the hook. So long as the fish can swim at the surface and breathe air it remains alive throughout the night, but if the air bladder is perforated it loses its buoyancy and probably dies of asphyxia.

Although small, it is a well flavoured fish but only the poorest classes eat it, as the majority are repelled by the unattractive nature of its abode.

Reproduction. According to Hamid Khan, the female swims belly upwards, the male lies over her crosswise and spurts milt over the eggs which are liberated during one minute intervals in batches of 200 or 300. Both fishes keep afloat during the process by means of their fins.

In Ceylon the swarms of fry are occasionally found in the back waters of streams.

Young specimens have been taken in a pond at Katupota on August 5th, 1926, which were 13 mm. long and in a stream at Diyatalava on August 7th, 1926, which were 23 mm. long.

Distribution. Taken both in flowing and sedentary water especially in stagnant shallow ponds. Found from sea-level to Diyatalava (U.P) 1,217 metres above sea level. When taken from ponds with comparatively clean water in some localities such as Gampaha, Dehivala (W.P.), Galle (S.P.), *Channa orientalis* is found together with this fish in equal numbers. However, at Mankulam (N.P.) this is the only Ophicephalid in the forest pools formed along dried up stream beds. It has not been

taken from the Tissamaharama tanks and ponds where *O. punctatus* appears to be the sole but abundant representative of the family.

O. gachua can withstand a considerable range of temperature from the warm waters arising from the hot springs at Kanniya (E.P.) to the cold waters of Diyatalava (U.P).

Colombo, Kelaniya, Kaluaggala, Yakvala, Kirindivella, Athidiya, Kalutara, (W.P).

Katupota !, Kurunegalla, Arnamaduva veva, (N.W.P).

Pilapitiya !, Kegalla, Nambapana, (Sab. P).

Marambe !, Matara, Galle, Bentota, (S.P).

Kandy, Peradeniya !, Kadugannawa !, Ambanpitiya ela, Kotagala, (C.P.).

Murungan, Jaffna, Mankulam !, Vannivillankulam, (N.P.) !

Kanniya, (E.P).

Anuradhapura, Rambeva, (N.C.P).

Ceylon, India, Singapore, Malay Peninsula, Siam, Andaman Islands, Baluchistan, Afghanistan, Persia.

Genus **Channa** Gronow.

Elongate, cylindrical fishes with cycloid scales. Fins spineless, unpaired ones long. Ventrals absent. Gape wide. Teeth on palate well developed. Canines on lower jaw.

Channa orientalis Bloch et Schneider. (Plates XXIII, XXVII)

C. orientalis Bloch et Schneider, Syst. Ichth, 1801.

Local names. *Kolla kannaya, (S.)—Leaf kannaya*
Gas kannaya, (S.)—Tree kannaya

Fins. P 13–15. V 0, D 31–34 A 20–22. C 13–15.

Scales. LL 9–12·I·27–30

(*b*) L tr. $\frac{4\cdot5–5\cdot5}{5\cdot5–6\cdot5}$

Predorsals 6–7, prenasals 17–20, scales between lateral line and insertion of pectorals 2. Scales from eye to posterior edge of preopercle 5–6. Scales from anterior to posterior edges of opercle 2–3.

Measurements. Head 2·8–3·5, eye 4·7–7, interorbit 1–2·15, snout 1–1·5 orbits. Length of gape 2·5–2·75 in head. Width of gape 2·5–2·75 in length of head.

Depth of body 5–6·5 in entire length. Lateral line descends under 8th dorsal ray. Pectoral fin reaches anal and is equal to postorbital part of head or is contained 4–5 in entire length. Ventrals absent. Caudal 3·9–5 in entire length. This fin is almost a perfect circle when

expanded in the living fish. Dorsal ahead of anal by 10–11 rays or by half the base of anal or by about one third base of dorsal.

An elongate fish with rather an oblique gape which does not extend beyond the eye. Head rather blunt and rounded. It is the smallest member of the family and seldom exceeds 105 mm. in length.[1]

Sense pits of head single. Frontal shield touches the single internasal anteriorly and the cephalic rosette posteriorly. Prenasals absent. Rosette lies between and touches the frontal and basal shields, is regular, circular, and consists of the median shield surrounded by six marginals. Both frontal and basal shields are triangular or pentagonal in shape. (Plate XXIII, fig. 6).

Teeth. Cardiform bands on intermaxillaries, palatines and mandibulars. Each mandibular has 10–20 canines behind a single row of villiform teeth which deepens to about 7 rows at symphysis.

Vomerines consist of a single row of 3–4 strong caninoid teeth on each side, behind a single villiform row. Palatines are in line with them and on each side is a row of 10–12 caninoid teeth behind a single row of villiform teeth.

Intermaxillaries, villiform, pluriserial, cardiform bands. Pharyngeals, canines in ovoid patches. No teeth on parasphenoid.

Colours. This fish does not present any well marked colour variation although some individuals are lighter than others and possess a blue abdomen.

As in *O. striatus* this species exhibits although less perfectly, the dark W-shaped transverse bands which open anteriorly. These bands are 2 or 3 rows of scales wide and are about twice as broad as their interspaces which usually consist of a single row of scales and show best on young specimens of about 50 mm. in length. This fish is almost identical with *O. gachua* in colour. Dorsally it varies from a light cinnamon to brown and is an olive brown ventrally. The second limbs of the "W" cross the back in 10–13 dark stripes which fuse on reaching the lateral line, but in the posterior W shaped bands the third limbs extend ventrally nearly up to the base of the anal fin. Belly and throat bluish green. A dark lateral stripe extends from the snout through the eye to opercle, while another runs from the anterior nostril along the maxillary border into the light ventral colouration of the preopercle. There is a diffuse dark line running across the top of the head from the right eye to the top of the left gill cleft, which intersects a similar line from the left eye to the right gill cleft. There is also a dark line connecting the anterior nares and another behind it connecting the eyes across

1. "Luhula nethi vallai kannaya pandithayalu." Sinhalese proverb meaning "When the pond contains no Luhula the Kannaya becomes pompous."

the interorbital space. All these lines on the top of the head are intensified after the fish has been kept in dark surroundings. Occasionally a series of minute black dots appear on the sides of the head and body. The eyes are orange with a brown outer rim.

The dorsal fin has an upper and lower longitudinal pale olive brown band separated from each other by a bluish green band. The outer margin of this fin is orange with light coloured distal tips to the fin rays. The 1st limbs of the "W" bands enter the basal portion of the fin and in young specimens extend across it to the outer margin.

Anal bluish green indistinctly crossed by the 4th limbs of the "W" bands. There is a dark olive or slate coloured longitudinal band near the external edge, but no orange margin. The distal tips of the fin rays are white giving the fin a white margin. Pectorals orange with 6–7 transverse dark stripes on each which are equal to or wider than the interspaces. Caudal a pale yellow with seven transverse dark stripes which are much wider than the interspaces. The margin of this fin is orange.

In the young specimens the colours are as follows: A pale reddish yellow dorsally with a deeper diffuse lateral streak of orange from snout to caudal fin, extending through upper half of orbit. A dark stripe from snout to posterior margin of opercle. Lower half of animal, including lower half of orbit, a dark grey. Vertex pigmented with black. Fins pale yellow. After attaining complete colouration an occasional specimen displays an ocellus on the last five rays of the dorsal fin, occasionally there may be two or three such ocelli one behind the other or there may be an irregular dot or streak of black pigment. Generally there is no such mark or ocellus. This ocellus has been found in specimens ranging usually from 25–53 mm. At Pelmadulla, where this fish is the commonest Ophicephalid, the ocellus often persists in adult specimens as seen from the following table :—

Length of fish in mm.	*Number of dorsal ocelli*
80	0
60	1
80	0
63	1
67	2
65	1
56	3
78	1
88	1

Sense pits. Single at all stages of growth.

Reproduction. Young with mother taken at Nugegoda, January 25th, 1928. Female with mature ova Yakvala, March 24th, 1928.

Distribution. In pools of clean water close to streams. It is often taken together with *Ophicephalus gachua* which it resembles greatly in shape and colour.

Yakvala!, Athidiya!, Dehivala!, Homagama, Anassigalla, Nugegoda, (W.P.)!

Vakvella!, Udugama, (S.P).

Vaganga, Kahavatta!, Pelmadulla!, Rakvana, (Sab. P).

Ceylon.

Sub-order ANABANTOIDEA

Spiny finned, compressed, oblong fishes. Head conical or compressed with serrate margins to free edges of cheek bones. Scales equal in size. All or some cephalic scales cycloid, all body scales ctenoid. Mouth protractile, small. Teeth weak, conical in a few bands. Palate edentulous except in *Anabas*. Gill membranes scaly, united, free from isthmus. Branchiostegals six. Suprabranchial air cavities contain respiratory organs of perforate, convoluted, bony, lamellae covered by a vascular mucous membrane. Air bladder extends into tail up to caudal fin and has a median septum supported by haemal arches of caudal vertebrae. Dorsal and anal fins long, with numerous spines anteriorly, anal shorter or longer than dorsal. Ventrals thoracic with a single spine and usually an elongate outer ray. Lateral line well developed or rudimentary. Nest building fishes which withstand desiccation for considerable periods. Essentially vegetarian they are not averse to insects, small fishes and decaying organic matter. Several of the smaller forms brightly coloured.

Key to genera of Anabantoidea

A. Outer ventral ray bifid.
   (a) No elongate ventral ray.
   .... *Anabas.*
   (b) Outer ventral ray in two elongate filaments.
   .... *Polycanthus.*

B. Outer ventral ray a single elongate filament.
   (a) Lateral line complete
   .... *Osphronemus.*
   (b) Lateral line rudimentary
   .... *Macropodus.*

Genus **Anabas** Cuvier.

Head bluntly conical, body oblong, compressed, mouth slightly protractile extending to orbit. Teeth on jaws and palate, small conical, fixed. Scales on top of head cycloid, rest ctenoid, medium sized, strong. Lateral line broken posteriorly into two portions which overlap. Dorsal fin longer than anal and commences anterior to it. Both have spines. Ventral inserted under pectoral, has a single spine and a simple bifid external ray. Pectoral has no spine. Caudal truncate with rounded corners. Opercle, subopercle, interopercle and preorbital strongly denticulate in the adult. Pyloric caeca 4–0. A vascular mucous membrane covers two or more convoluted, perforate, osseous lamellae in suprabranchial air chamber and enables these fishes to remain several hours without water. Pharyngeal teeth numerous, small and strong.

Anabas testudineus (Bloch). (Plate XXVIII)

Anthias testudineus Bloch, Ausland Fische 7, 1795.

Local names. *Kavaiya*, (*S.*)
Pol kavaiya, (*S.*)—*Coconut kavaiya* (*large adult*)
Kavaiyan, (*T.*)

Fins.[1] P15–16. V 1·5· D XV-XVII. 9–10. A IX-XI. 9–11. C 17

Scales. LL 15–19. 10–15, L tr. $\frac{4\cdot 5}{9\text{–}10\cdot 5}$. Predorsals 15[2], preventrals 14–15.

Scales between insertions of pectoral and ventral fins 3–4.

Scales from eye to posterior edge of preopercle 4–5.

Scales from anterior to posterior edges of opercle 3–4.

Measurements. Head 2·6–3·2, eye 4–5·5, interorbit 1·5–2, snout 0·9, depth of body 2·5–3·5, lateral line descends 2 rows of scales under the one but last dorsal spine. Pectoral fin 4–4·25, ventral 6·1, caudal 4–4·8 into length. Caudal truncate in young, with rounded corners in adult. Origin of anal under 8–10 dorsal spine. Base of dorsal ends anterior to base of anal.

Dorsal profile convex, gape small, oblique, re ches mid eye. Preorbital, interopercle, subopercle and opercle strongly serrate in adult, but entire in young with caudal ocellus and in specimens less than 25 mm. in length. The serrations blunten with age. Branchiostegal rays 6. Pyloric caeca 4.

Length of fish 156 mm.

1. The spines are denoted by roman numerals.
2. Predorsals reckoned from snout to dorsal fin.

Teeth. Small, conical, fixed. Intermaxillary has an outer large row followed by two finer rows. Vomerines three or four in number. Mandibulars in two rows with 3 or 4 rows at symphysis. A "T"-shaped arrangement of about 16 teeth on parasphenoid, behind which are the suprapharyngeals in two ovoid patches. Infrapharyngeals in two triangular patches with apices directed anteriorly.

Suprabranchial organ. Consists of from 2 (in the young) to 6 or more (in the adult) osseous, fan-shaped lamellae which are freely perforated with oval holes, strongly convoluted and arise from a central axis. They are superimposed and invested with a vascular mucous membrane which is stretched over the perforations. The blood vessels lie on the lamellae and ascend into the higher ones through some of the holes.

Colours. Dark to light green dorsally, greenish yellow to orange ventrally. About ten indistinct dark olive transverse stripes on body. Two black spots, one at hind end of opercle, the other at posterior termination of the lateral line. The former usually absent in the adult, both spots absent in old specimens. Vertex pink. Dorsal fin pale green, pectorals and ventrals light red, anal and caudal pale pink and green. Eye orange.

The young are very similar to the adults with a large brown edged ocellus at base of caudal fin, belly pale green or white instead of orange and about 10 distinct dark transverse stripes on body, the last of which curves around the ocellus. A vertical dark diameter to orbit.

The ocellus is best marked in specimens 13–20 mm. long.

This species is commonly referred to under the name *Anabas scandens*, but priority must be given to the name under which it is described in the present paper. Since the days of Daldorff (1797) this species has been known as the "climbing perch" owing to its alleged arboreal tendencies, but its well-known ability to withstand rigorous droughts appears to have been exaggerated. Experiments by the writer have shown, that this species can live for 48 hours without water if kept in a moist earthen vessel in the dark, but if exposed to light or kept under mud dies much sooner. The tree climbing habit has not yet been observed by the writer although the fish is known to cross dry land in quest of water.

Progress on land is by a series of scrambling movements effected by hooking the spines of its ventral fins and distended subopercles into the ground. The animal travels at a fair rate with a scraping, sidelong motion and by flexion and extension of the body and tail.

It visits newly sown paddy fields at night in order to feed on the grain. Specimens in a glass tank fed eagerly on paddy, using the pharyngeal teeth to remove the husk which was ejected through the mouth.

The noise of grinding the grain was audible as a series of harsh, grating, clicks which were transmitted through the glass.

Anabas depends on aerial respiration to as great an extent as do the Ophicephalidae, but differs in its method of expiration in letting out the vitiated air through the gills instead of through the mouth as is usual with the latter fishes. The exact location of the air bubble can be proved by a simple experiment. A small hole is bored from the top of the skull into each air chamber. The fish is not inconvenienced beyond the fact that when he seeks to dive down after coming to the surface for air, the pressure of the water causes two streams of bubbles to escape from these holes.

The presence of these respiratory chambers enables the fish to live in very foul water, but if kept in such for long periods, the animal is subject to fibroid carcinomatous growths. For a fresh water fish, Anabas can withstand a considerable range of salinity and the writer has within a few days accustomed individuals to live normally in a mixture of 1,200 cc. of sea water to 500 cc. of fresh.

Anabas testudineus in Ceylon is remarkable in that it shows a lower number of dorsal spines than has hitherto been recorded for this fish. The collection in the Colombo Museum consists of 62 specimens, of which four had only fifteen dorsal spines and ten anal spines apiece. These specimens were taken at Colombo, Jaffna and Badurueliya.

The spines of the remainder were arranged as follows :—

Number of fishes	*Dorsals*	*Anals.*
7	16	9
50	16–17	10
1	17	9
1	17	11

Anabas testudineus is economically the most important member of the sub-order in Ceylon, and is usually present in considerable numbers in fish markets. In spite of being small and somewhat bony it is one of the few fresh water fishes which has the flavour of the flesh unaffected by muddy water, hence its popularity. It is also commonly employed to keep wells free from decaying matter.

It is a gregarious fish, several individuals inhabiting the same burrow or submerged hollow log. Fishermen often take them by diving under

water and catching the fish with their hands; and at times hold one in their teeth as well, prior to rising to the surface. The hard scaled fish occasionally slips between the teeth into the throat where its distended subopercles and fin spines fix it so firmly that deaths due to this cause are not uncommon.

The fish is also captured in cast nets, karak geddi, and by rod and line with boiled rice, prawns or earth worms as bait, and also by baling water out of ponds.

Reproduction. This species breeds more than once annually as seen from the following table. Young in the ocellus stage were taken from

Batuluoya (N.W.P.)	on	May 12,	1927
,, ,,	,,	Nov. 7,	1926
Kurusadiya, (N.W.P)	,,	June 9,	1926
Chilaw, (N.W.P)	,,	Dec. 4,	1927
Murungan, (N.P)	,,	Dec. 8,	1927
Vavuniya, (N.P.)	,,	Nov. 27,	1928

The egg has a single large oil globule in the yolk and is planktonic. Pale yellow in colour and ranges from 0·8–1 mm. in diameter.

Distribution. Found in the low lying portions of Ceylon, in fresh water tanks, ponds and streams and also in lakes which have access to the sea. It is unknown from the hill districts, and although widespread in distribution is localized to one or two bodies of water in each locality. Specimens have been collected from

Colombo, Kelaniya, Yakvala, Veyangoda, Panadura, Bolgoda, Kalutara, Baḍurueliya, (W.P.)

Anuradhapura !, Rambeva !, Medavachchiya !, Nochchiyagama !, (N.C.P.)

Batuluoya !, Chilaw, Kurusadiya, (N.W.P.)

Jaffna !, Murungan, (N.P.)

Bentota, Vakvella !, Tissamaharama, (S.P.)

Ceylon, India, Burma, Siam, Malacca, Tonkin, South China, Malay Peninsula, Malay Archipelago, Philippines.

Genus **Polyacanthus** (Kuhl.) Cuvier.

Strongly compressed, oblong. Mouth small, oblique, protractile, reaches front of orbit. Jaws equal, but chin prominent with age. Teeth small, fixed, conical, none on palate. Scales medium, cycloid on head, ctenoid on body. Lateral line complete, rises and falls in two step-like gradations. Dorsal longer than anal, its origin above base of pectorals and anterior to that of anal. Its posterior end level with that of anal. Soft dorsal and anal have elongated posterior rays and scaly bases.

Ventrals, under pectorals, with an anterior spine. The outer ray produced into two filaments. Preorbital and preopercle finely serrate.

Polyacanthus signatus Gunther. (Plate XXIX)

Polyacanthus signatus Gunther, Catalog. Fish. Brit. Mus. Vol. III, 1861.

Local name. *Pulutta*, (*S.*); *Kolla modha* (*S.*)—*Leaf lates*

Fins. P 10–12. V 1·5 D XVI–XVIII. 8–10 A XIV–XVI. 10–12. C 14.

Scales. LL 2–3. 10–15. 2–3. 13–16.

[1] L tr. $\frac{4\cdot5}{9\cdot5-10\cdot5}$; predorsals 20–22, preventrals 12–14.

Scales between insertions of pectoral and ventral fins 4.

Scales from eye to posterior corner of preopercle 5–6.

Scales from anterior to posterior edges of opercle 3–4.

Measurements. Head 2·6–3, eye 3·8–4·5, interorbit 1, snout 1, depth of body 2–2·7. Lateral line ascends and later descends two or three rows of scales. Pectoral fin 3·9 4·6 into length. Ventral fin has outer ray elongated into two filaments which reach to about 11th anal spine.

Caudal fin 2·9–3·5 into length ; truncate in young, rounded and with filamentous median rays in old specimens Origin of anal under third dorsal spine, its 5 or 6th soft ray elongated. Dorsal fin ends slightly in advance of end of anal, its 3rd or 4th soft ray elongated. Dorsal profile concave vertex convex, more so in old specimens Gape oblique, small, extends to anterior edge of orbit. Jaws level, chin becomes prominent with age.

Branchiostegal rays 6.

Length of fish 120 mm.

Teeth. Two rows of fine fixed conical teeth behind a single outer row of enlarged teeth, in both jaws. A small ovate patch of eight teeth on parasphenoid. Suprapharyngeals in two ovoid patches, infrapharyngeals in two triangular patches with apices directed anteriorly.

Suprabranchial organ. Consists of one or two osseous lamellae invested in a vascular mucous membrane. The involutions are few but wide and there are one or two perforations.

Colours. Olive dorsally, green on sides and belly. Specimens from flowing water show blue lunules on sides. Black spot under base of soft dorsal and at base of pectoral. Fins pale orange to olive. Eye green with a yellow rim round pupil.

1. Over highest bend of LL.

Reproduction. Specimens taken at Batuluoya (N.W.P) on July 4th, 1928, were full of mature ova which were bright pink in colour and 1 mm. in diameter.

Distribution. Lives in colonies in submerged tree trunks and amongst roots and weed in hill streams and in the low–country of Ceylon, in ponds, tanks, and streams of fresh water.

Attidiya ! Yakvala, Badurueliya, Moratuwa, Tebuvana, (W.P.)
Kurunegalla !, Batuluoya !, Chilaw, (N.W.P) !
Balainna, Nambapana, Warakapola, (Sab. P).
Ceylon, Java.

Genus **Osphronemus** Lacépède.

Strongly compressed, oblong. Mouth small, oblique, protractile. Jaws equal, but chin prominent with age. Teeth small, pluriserial conical, fixed, on jaws only. Scales medium, ctenoid. Lateral line of single tubes in a straight line. Labyrinthiform accessory respiratory organs present. Dorsal much shorter than anal. Its origin far behind and its termination considerably anterior to origin and termination of anal. Ventrals under insertion of pectorals, with the first ray produced into a single filament. Preorbital, preopercle and subopercle finely serrate along external lower edge. Opercle entire. Only a single species.

Osphronemus goramy Lacépède. (Plate XXX)

[1] *Osphronemus goramy* Lacépède, Hist. Nat. Poissons III, 1802

Local name. *Goramy, Gourami.*

Fins. P 13–15. V 1·5. D XII–XIII. 10–12. A X–XI. 20–22. C 16.

Scales. LL 32–36 L tr. $\frac{6\cdot5\cdot-7\cdot5}{11\cdot5-12\cdot5}$; predorsals 27–28.

Preventrals 15–17.

Scales between insertions of pectorals and ventrals 5.

Scales from eye to posterior edge of preopercle 3–4.

Scales from anterior to posterior edges of opercle 3.

Measurements. Head 2·9–3·65, eye 3·5–5·5, interorbit 1·4–2·5, snout 1–1·9, depth of body 2·1–2·3.

Pectoral fin reaches base of last anal spine or 6th dorsal spine in young specimens, not so far in old ones Pectoral shorter than head by half a snout length.

1. Several subsequent authors have termed it *Osphromenus gourami.*

Ventral fin has the outer ray single, elongated into a jointed filament which extends to beyond the caudal fin.

Caudal 3–4·2 into entire length.

Base of soft dorsal contained 2–3 in base of soft anal.

Dorsal profile strongly concave in young specimens, less concave in old ones. Preorbital, preopercle and subopercle with finely serrate lower edges.

Gape, small, oblique, does not reach orbit, jaws level, chin becomes prominent with age.

Branchiostegal rays 6. *Osphronemus goramy* is oblong when young, but has a more circular outline when old.

Length up to 500 mm.

Teeth. Conical, pluriserial, fixed. Intermaxillary has an outer large row followed by 5 or 6 finer rows which decrease to three rows posteriorly. Vomerines none. Mandibulars in a single row posteriorly increasing to 5 or 6 rows at symphysis. Parasphenoid has a cluster of four or five teeth. Suprapharyngeals in ovoid patches with two concentric, anterior, ridges of which the first is edentulous, the second dentigerous. Infrapharyngeals in contiguous, triangular patches.

Suprabranchial organ. Five or six superimposed osseous lamellae which are broadly convoluted and pierced by numerous holes. A vascular mucous membrane invests them.

Colours. Brown or slate coloured above. Black spots on head, and at top corner of opercle. Chin and vertex pink, sides silvery with pale pink lines. Dorsal, anal and caudal, brown or slate with a pink tinge.

The young have seven or eight dark transverse bands. A dark spot above soft anal and another at insertion of pectoral.

Osphronemus goramy was successfully introduced into Ceylon by Dr. A. Willey in 1909. Ten years previous to this Mr. G. M. Fowler imported some specimens which did not survive. The specimens of Dr. Willey were brought from Java by the late Mr. Kelway Bamber and were fed on boiled rice and minced raw meat during the four days sea voyage. The fishes, which were 15–20 cm. long, arrived on the 15th of September and were placed in a well in the Colombo Museum grounds. In October all but three were removed to the Botanical Gardens at Peradeniya where they bred freely and enabled further transplantations to be made, until the pond in which they lived overflowed with the Mahavelliganga during floods.

Today the fish is found in a few ponds, several of which are privately owned and one of the original fishes in the Colombo Museum is still alive after twenty years and very tame.

This species has not yet obtained a firm footing in our waters probably owing to the presence of predaceous fishes such as *Ophicephalus*, and lakes should be cleared of these prior to stocking with Goramy.

The fish is hardy, thriving in sedentary or flowing water and possessing well flavoured flesh and, according to Commerson, it is reared in Batavia in large earthen jars where it is fed solely on the water plant, *Pistia natans*. In our waters the fish thrives best if fed once or twice a week with parched rice, and does better in up-country waters, possibly owing to the comparative scarcity of Ophicephalids and the cooler temperature.

Osphronemus is essentially a vegetarian and it is said that the Japanese water hyacinth disappeared from the Goramy pond at Peradeniya and the local water lily from the Batadola pond at Veyangoda. It also feeds on parched rice, decaying organic matter and small fishes, and this omnivorous habit has earned it the name of "River pig" in the Mauritius.

Reproduction. The fish is reported to breed when six months old and builds a bird-like nest of mud and weed, to which the ova are attached. The young, according to Indian observers, hatch out after a month and are guarded by the parents.

Distribution. Colombo Museum well, (W.P.)

Batadola Estate, Veyangoda, (W.P) !

Peradeniya, Royal Botanical Gardens, (C.P.)

Drayton Estate, Kotagalla, (C.P.)! Mahavilla Estate, Ulapane, (C.P)! also introduced to Galle reservoir, (S.P) and Kandy Lake, (C.P).

Siam, Penang, Malacca, Malay Archipelago. Introduced to Ceylon, India, the Mauritius, Cayenne, Seychelles, Australia and France.

Genus **Macropodus** Lacépède.

Compressed, oblong. Mouth small, oblique, protractile not reaching orbit.

Teeth small, pluriserial, conical and fixed, on jaws only. Scales medium, on top of head cycloid, remainder ctenoid. Lateral line interrupted and rudimentary, being represented by a shallow pit on each scale. Dorsal shorter than anal. Its origin above that of latter. Both fins

have their posterior rays elongated and possess a scaly basal sheath. Caudal commonly bilobate, rarely lanceolate. Ventrals with a single spine, under pectorals with the outer ray produced into a single filament. Preorbital, preopercle, interopercle and subopercle finely serrate.

Macropodus cupanus (Cuv. et Val.). (Plate XXXI)

Polyacanthus cupanus Cuv. et Val ; Hist Nat. Poiss, VII, 1831

Local names. *Thal kossa, (S.)—Palmyra fibre fish.*
Thal kaddaya, (S.)

Fins. P 11. V 1·5. D XIII–XV. 5–7. A XVII–XX. 10–13. C 13.

Thirty-four specimens were examined, of these

20	had	15	dorsal	spines	1	had	20	anal	spines
11	,,	14	,,	,,	9	,,	19	,,	,,
3	,,	13	,,	,,	14	,,	18	,,	,,
					9	,,	17	,,	,,

Scales[1] —LL 9–13. 17–20, L tr. $\frac{3\cdot5\text{–}4\cdot5}{6\cdot5}$. predorsals 19–21.

Preventrals 8–9.

Scales between insertion of pectoral and ventral fins 2–3.

Scales from eye to posterior corner of preopercle 4.

Scales from anterior to posterior edges of opercle 3.

Measurements. Head 3–3·25, eye 3·2–4, interorbit 1, snout 0·8–1. Length of gape rather less than eye diameter; depth of body 2·75–3. Lateral line exists as rudimentary pits over the first 9–13 scales. Pectoral fin equals head without snout and is contained 3·75–4·5 in entire length of fish. Ventral fin has the outer ray elongated into a single filament which reaches 7th or 8th anal spine.

Caudal fin 2·3–2·6 in entire length if median rays elongated, otherwise 3–3·5. Origin of anal under that of dorsal, origin of soft anal under 5th or 6th ray of dorsal. Base of dorsal ends anteriorly to base of anal by five scales. The bases of both fins in scaly sheaths. Dorsal profile faintly convex. Gape small, oblique, far from orbit. Lower edge of preorbital has ten serrations.

Branchiostegal rays 6.

Length 40 mm.

1. The first figures of LL denote pitted scales; L tr. is without the scaly basal sheaths of dorsal and anal ; predorsals are from snout to origin of dorsal.

Teeth. Intermaxillary has a large outer row with 3 rows of finer teeth which taper into a single row posteriorly. Mandibulars have 3 or 4 rows of fine teeth at symphysis tapering to a single row posteriorly. No teeth on palate or parasphenoid. Suprapharyngeals in ovoid patches. Each has 3 concentric, anterior, fleshy ridges which are edentulous. Infrapharyngeals in triangular patches.

Suprabranchial organ. A single ellipsoid, flat, osseous lamella with a few perforations and covered by a vascular mucous membrane which forms a sac-like ventricle posteriorly.

Colours. Vary from dark olive to green, darker dorsally. A brown stripe at times extends from eye to corner of opercle Brown spots at times present on head. Elongated ventral ray red ; anal orange, other fins pale green. A round black spot at base of caudal which has 9–10 vertical rows of brown dots. Dorsal has 8–9 similar rows. Anal has 2 or 3 faint rows.

Distribution. Usually found within water logged coconut husks and under decaying vegetation or in water weed and is useful as a destroyer of mosquito larvae. Common in ponds and ditches in the low country.

Yakvala !, Colombo, Gampaha, Galkissa, Dehivala, Panadura, Kelaniya, Kalutara, (W.P.)

Arnamaduva, Batuluoya !, Chilaw, Kurunegalla, (N.W.P.)

Anuradhapura, Rambeva, Medavachchiya, (N.C.P.)

Mannar, Jaffna (N.P) !, Mullaitivu, (E.P.)!

Marambe, Vakvella (S.P.), Nambapana, Kegalla, (Sab. P)

Ceylon, India, Malay Peninsula.

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EXPLANATION OF PLATES

Plate XXIII.

Fig. 1.—Diagrammatic head showing shields.
S.N.—Supranasal shield, F—Frontal.
S.O.—Supraocular, B—Basal.
I.N.—Internasal, P.N. Prenasal.
M.—Median, A—Arrow-head.
Fig. 2.—Head of *Ophicephalus marulius*
Fig. 3.—Head of *O. striatus.*
Fig. 4.—Head of *O. punctatus.*
Fig. 5.—Head of *O. gachua.*
Fig. 6.—Head of *Channa orientalis.*

Plate XXIV.—O. marulius $\times \frac{1}{4}$.

Plate XXV.—O. striatus $\times \frac{1}{4}$.

Plate XXVI.—O. punctatus $\times \frac{1}{5}$.

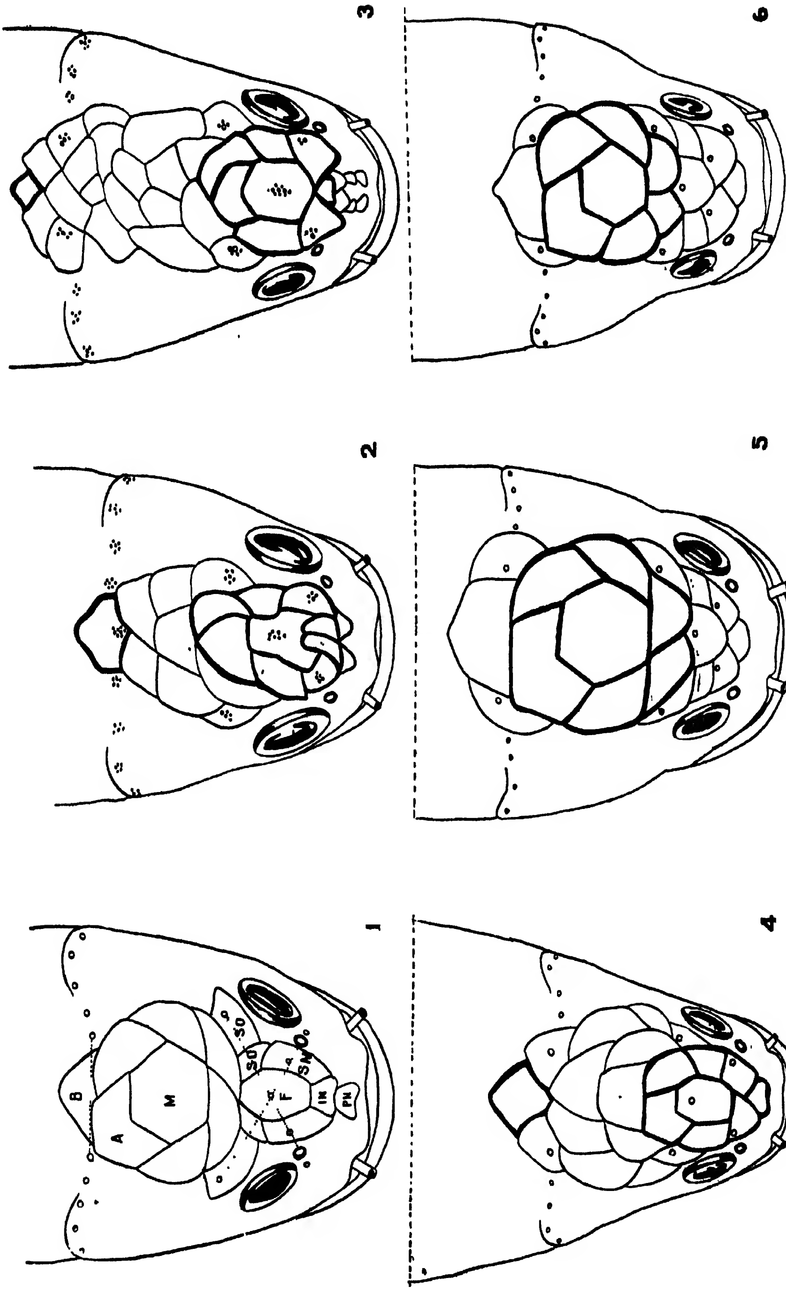
Plate XXVII.—C. orientalis $\times 1\frac{3}{5}$.

Plate XXVIII.—Anabas testudineus $\times$ 1.

Plate XXIX.—Polyacanthus signatus $\times 1\frac{1}{4}$.

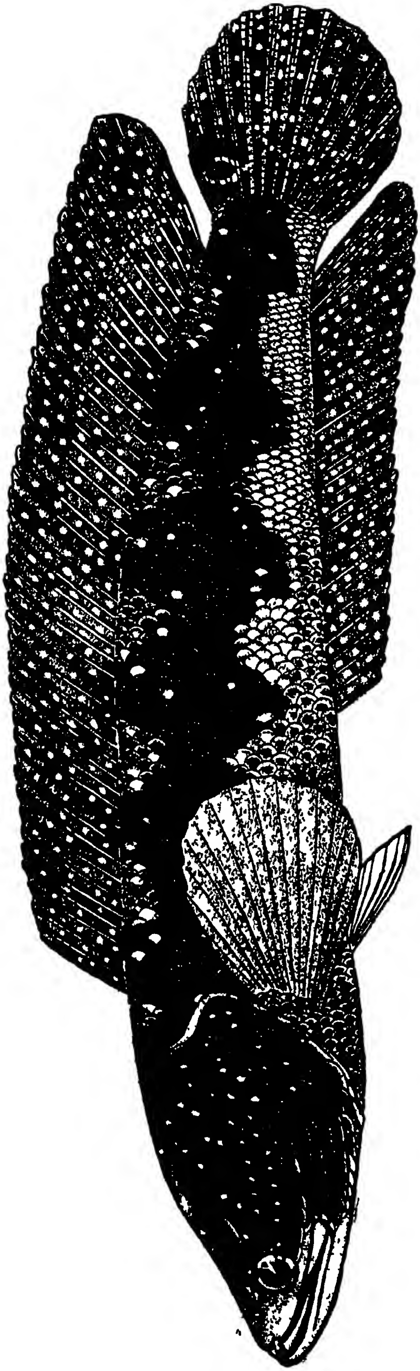
Plate XXX.—Osphronemus goramy $\times \frac{1}{3}$.

Plate XXXI.—Macropodus cupanus $\times 3\frac{8}{5}$.



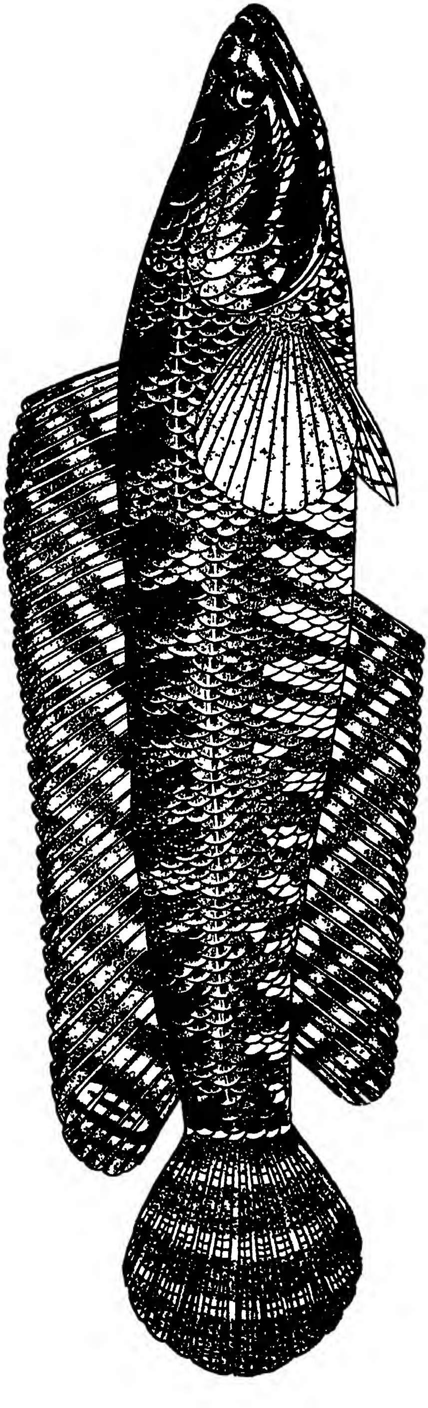
Ophicephalid head shields.

P. E. P. Deraniyagala, del.



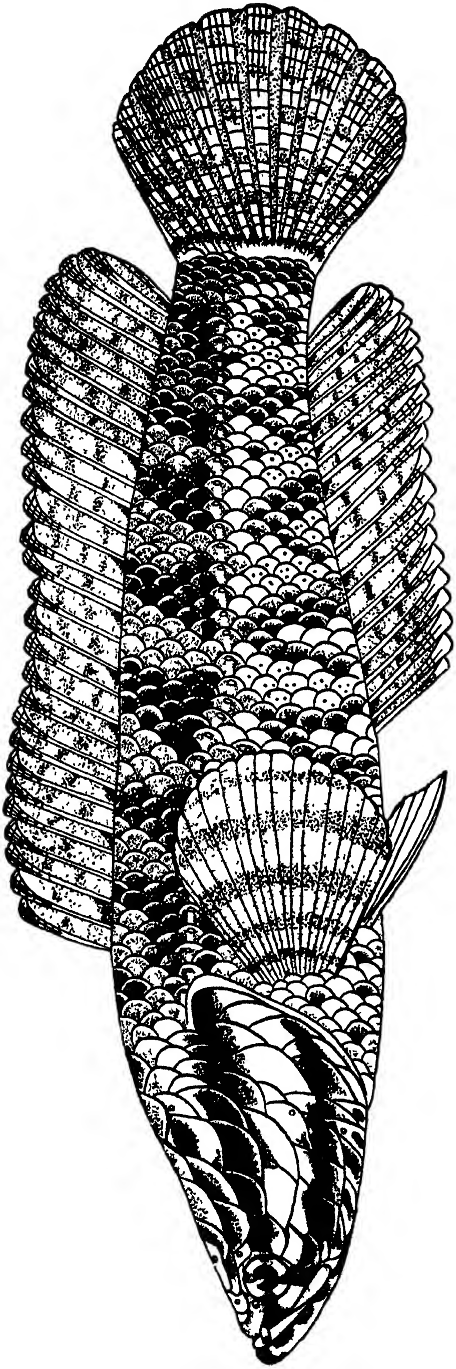
Ophicephalus marulius Ham. Buch.

P. E. P Deraniyagala. del



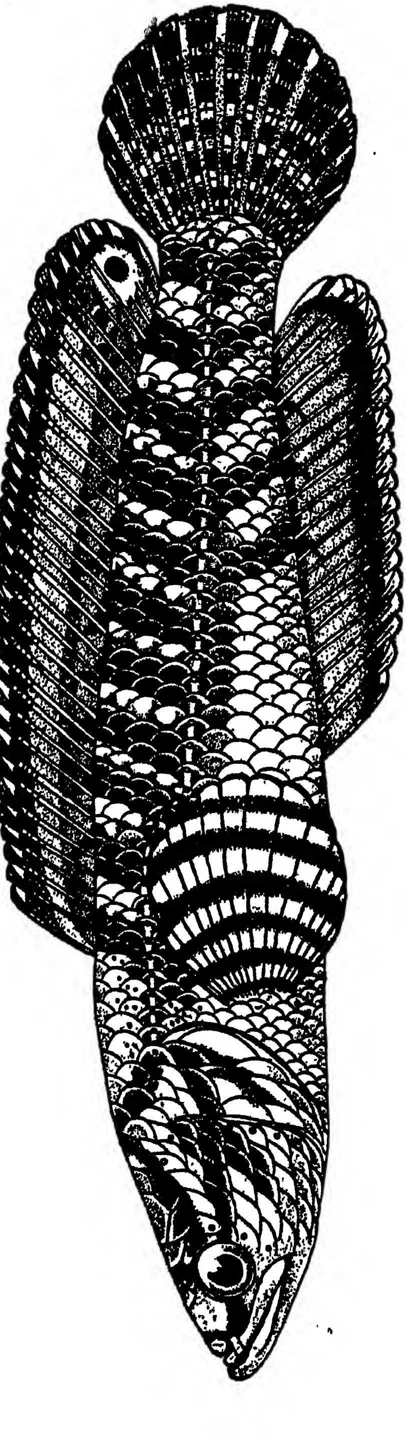
Ophicephalus striatus Bloch

P. E. P. Deraniyagala del



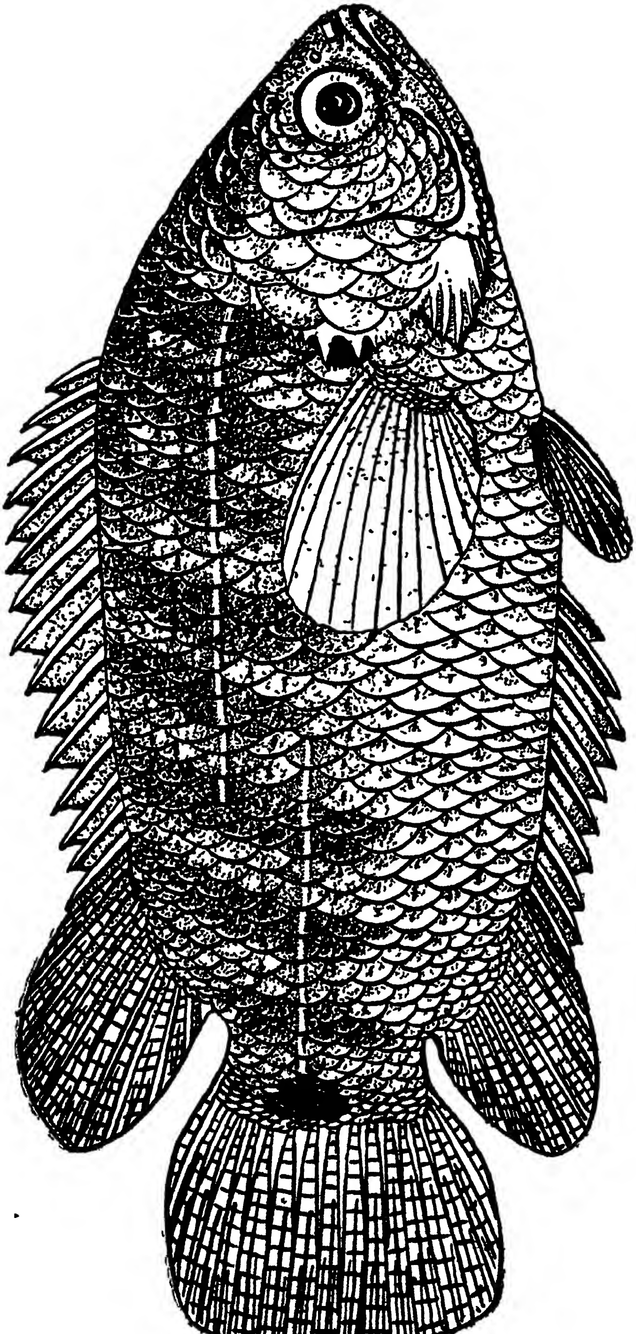
Ophiocephalus punctatus Bloch.

P. E. P. Deraniyagala del.



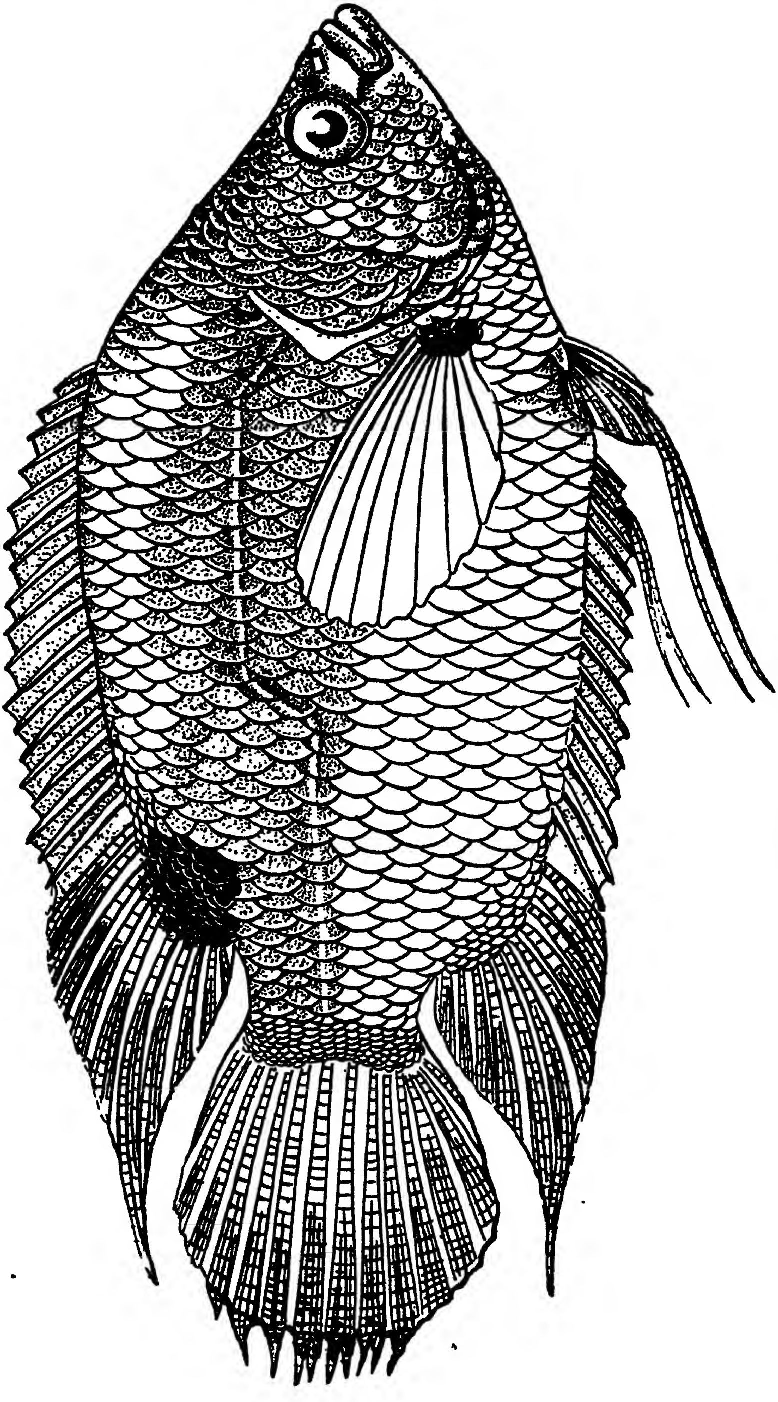
Channa orientalis Bloch et Schneider.

P. E. P. Deraniyagala del.

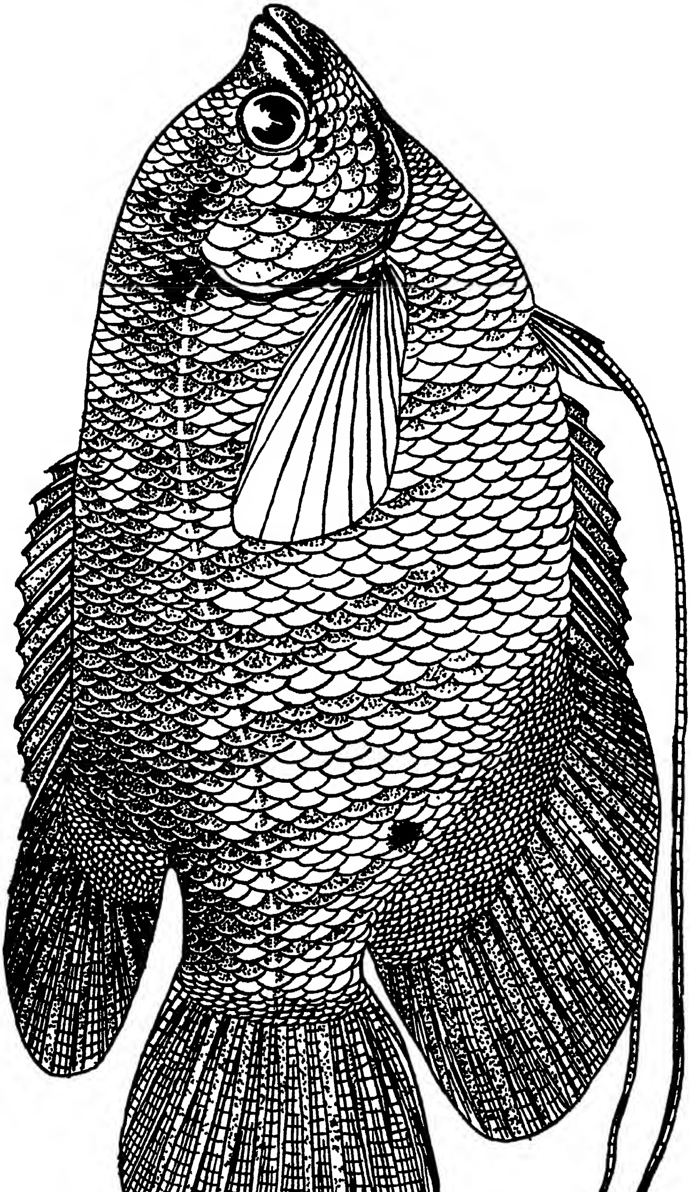


Anabas testudineus (Bloch)

P. E P Deraniyagala d

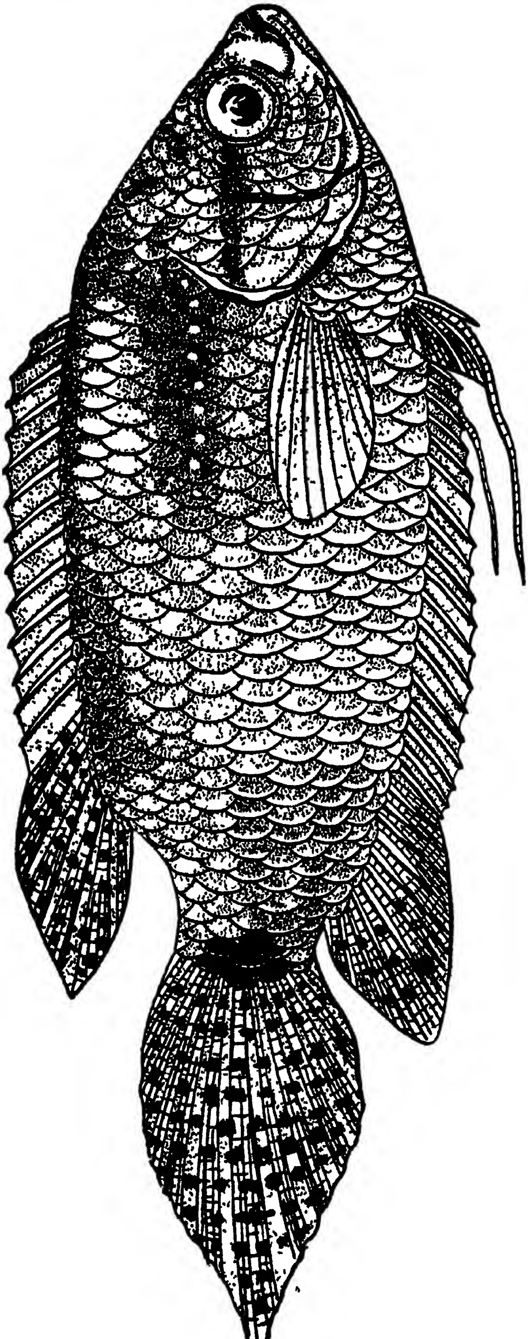


Polyacanthus signatus Günther.



Osphronemus goramy Lacépède

P. E. P. Deraniyagala del.



Macropodus cupanus (Cuv et Val.)

P. E. P. Deraniyagala del.

New and Rare Ceylon Shrews

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

While resident in the Galaha district, during 1928, I received a small shrew which was brought in to me from a village below New Forest Estate in the Nilambe Valley.

This shrew appears to be new to science. Although I only obtained a single specimen, it is so distinctive and entirely different to any other Ceylon shrew, that I do not hesitate to describe and name it as a new species. It is evidently referable to the genus Crocidura.

Crocidura miya sp. n.

Size small, head and body larger than in C. horsfieldi ; tail long and slender, longer than the head and body, mouse–like, semi–naked with a few long hairs towards the base only; ears short and not very noticeable, naked ; hind feet long and slender, semi-naked ; fore feet longish ; claws minute, smaller on the fore feet than on the hind feet ; snout rather short, not much swollen at the sides ; lateral glands developed.

Skull typical of the genus ; the skull and teeth closely resemble those of C. horsfieldi but on a larger scale.

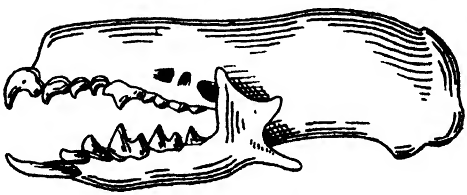


Fig. 1.—Skull of *Crocidura miya* sp. n. × 3

Fur. Close, soft and short, even in length ; vibrissae numerous, long.

Colour. General colour of the upper parts mouse–brown, with the base of the fur greyish ; underparts dark grey with a slight rufrescent

tinge; naked tail dusky black; snout dusky brown; semi-naked feet dusky grey with the claws pinkish white; vibrissae dark towards the base, paling to silvery grey towards the tips.

Measurements of the Type. Adult female.

Length, head and body 79 mm., tail 88 mm., hind foot 16 mm., ear 8 mm., head and snout 27 mm.

Skull. (The cranium of the skull of the Type is damaged, making full measurements impossible).

Condylo-incisive length 20·5 mm., breadth across molars 6 mm., intraorbital breadth 4·8 mm., dental length 8·75 mm., from 2p.m. to back of 4m. 5 mm., length upper incisors 2 mm., length lower incisors 3 mm.

Type. Adult female; now in the British Museum.

Collected on the 21st March, 1928, by W. W. A. Phillips at Moolgama village in the Nilambe district of the Kandyan Hills, altitude about 3,000 ft.

Distribution. Type locality, Moolgama village, near Galaha in the hills of the Central Province of Ceylon. At present the species is known only from the type locality.

Remarks. The name given to the species is derived from the Sinhalese vernacular term for both shrews and rats of all sorts.

The type specimen was killed in a terraced paddy field on a hillside. The local villagers say that the species is sometimes found in the small jungles around the village, but I failed to get a second specimen.

This shrew is easily distinguishable from all other Ceylon shrews by the length of its tail; it appears to be the only Ceylon shrew that has the tail longer than the head and body. It would seem to be a very uncommon animal.

Crocidura horsfieldi

While in Galaha, I also obtained specimens of this rare little shrew. Several of them were caught on New Forest Estate, at an altitude of from 3,000 ft. to 4,000 ft. and others were trapped on Deltotte Group some six miles distant, at an altitude of about 3,000 ft.

Previous to these specimens being secured, I do not think that the species has been observed since it was first discovered at Peradeniya, near Kandy, in 1856.

The description of this little animal given in Blanford's Mammalia (page 242) is not very accurate. In all probability it was taken from an old and discoloured specimen in the collection of the Indian Museum, Calcutta. My own description of the species, in my paper of 1928 on the Ceylon shrews (C.J. of S., Sec. B, p. 320) is also not accurate. It was taken, most probably, from the same specimen as Blanford's, as, at the time it was written, I had not been fortunate enough to secure for examination any fresh specimens ; it was, however, corrected to some extent in a note, inserted subsequently, at the end of the paper.

The following description is of specimens examined in the flesh, and corrects the aforementioned descriptions.

Crocidura horsfieldi. Size very small (head and body about 60 mm.) ; tail moderately long, slightly shorter than the head and body, not swollen[1] at the base but mouse-like, slender and tapering gradually, sparcely clad with minute hairs among which are scattered, on the basal half only, a number of longer hairs or fine bristles ; ears rather large and noticeable, naked ; muzzle narrow, very pointed and scarcely swollen at the sides ; feet small, semi-naked, equipped with very small claws ; lateral glands well developed in both sexes ; mammae in 3 pairs in the female.

Fig. 2.—Skull of *Crocidura horsfieldi* × 3

Fur. Very short and soft but not very dense ; whiskers (vibrissae) numerous, bushy and fairly long.

Colour. General colour dusky mouse-brown all over the upper parts ; underparts dusky grey ; head like upper parts, with the muzzle dusky flesh pink ; ears dusky, pinkish at the base ; tail dusky, rather lighter beneath ; feet dusky, lighter on the digits, dusky flesh-coloured beneath ; claws reddish white ; whiskers dark silvery.

1. Swollen at the base in adult males, at some seasons.

Body measurements taken in the flesh.

	Head & Body	Tail	Hind foot	Ear	Head & Snout	Locality
(a) *Males*						
No. 1.	55 mm.	50 mm.	12 mm.	8 mm.	22 mm.	Galaha
No. 2.	61 mm.	53 mm.	12 mm.	7 mm.	22 ·5 mm.	do.
Average	58 mm.	51 ·5 mm.	12 mm.	7 ·5 mm.	22 ·25 mm.	
(b) *Females*						
No. 3.	60 mm.	53 mm.	12 mm.	9 mm.	—	Galaha
No. 4.	61 mm.	47 mm.	11 ·5 mm.	8 mm.	21 ·5 mm.	do.
Average	60 ·5 mm.	50 mm.	11 ·75 mm.	8 ·5 mm.	21 ·5 mm.	

The skulls of these specimens measure:

	Greatest length.	*Condylo-incisive length.*	*Breadth across molars.*	*Interorbital breadth.*	*Mastoid breadth.*	*Dental length.*	*Front 2 p.m. to back 4m.*	*Length upper incisors.*	*Length lower incisors.*
(a) *Males*									
No. 1.	17 ·2	17 ·8	5 ·2	4	7 ·6 mm.	7 ·6 mm.	—	2 mm.	3 ·1 mm.
No. 2.	16 ·5	17	5 ·2	4	7 ·6 mm.	7 ·5 mm.	4 mm.	2 mm.	3 mm.
Average	16 ·8	17 ·4	5 ·2 mm.	4 mm.	7 ·6 mm.	7 ·5 mm.	4 mm.	2 mm.	3 mm.
(b) *Female*									
No. 4.	16 mm.	16 ·5	5 ·3 mm.	3 ·7 mm.	7 ·3	7 mm.	4 mm.	1 ·8 mm.	2 ·8 mm.

Habits, etc. The first specimen that I secured was turned up in stony ground on a tea estate, by a cooly who was forking among the tea. In all probability it was sheltering beneath the large stones and tea-roots when disturbed.

Another, secured later, was caught alive. It had fallen into a small pit, about two feet deep, cut among the tea, and was unable to climb out because of the steep sides. This specimen lived under observation, for several days. When first put into a large glass observation jar, with a little moss, it quickly went to sleep, but woke up to eat a moth and one or two worms. When sleeping it merely squatted down, not curling up as a small rodent would have done.

In the evenings it was more lively, jumping up and attempting to climb out of the jar; it was very quick in its movements and as night fell became increasingly active. Once or twice it was observed to sit up and comb its whiskers and face in much the same manner as a mouse will do. It devoured many worms that were given to it, showing a decided preference for them, but after a few days it died, for no obvious reason.

Another specimen was taken in a trap baited with coconut, but it also died very soon. I also had three others brought in to me by a cooly who had dug them out of small holes in the "patna" or grassland near the estate. In all probability the natural home of this little shrew is the patna grasslands of the hills around Kandy.

Feroculus feroculus.

A few months ago I received from the Director, Colombo Museum, for determination, a large, long-clawed shrew which proves to be a specimen of the very rare *Feroculus feroculus*—Kelaart's Long-clawed Shrew.

This specimen was picked up on the Horton Plains (alt. about 6,000 ft.) by Mr. W. E. Wait who found it lying dead on a path. It is, I think, the first specimen secured for examination since Dr. Kelaart first described the species in 1851. It is of particular interest as, previously, there was only a single specimen in existence—in the British Museum—and of this the skull is missing. The skull of this new specimen is therefore of great interest.

The description of this specimen, which supplements my paper of 1928 is as follows :

Feroculus feroculus. Size moderate ; fore feet with large claws of which that of the middle finger is slightly the longest ; hind feet moderately large, with small claws ; ears rather small (about the same size as in S.m. montanus), covered with short fine fur and scarcely visible; tail moderately stout, long, tapering, whitish at the extreme tip, clothed with very fine hairs among which longer and stouter hairs are scattered.

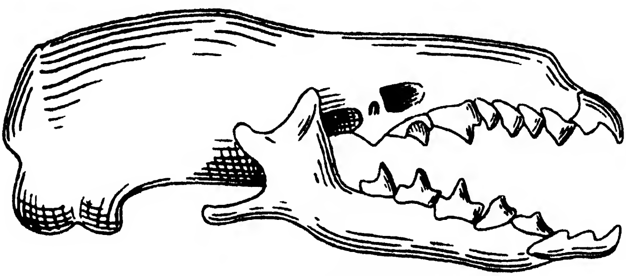


Fig. 3.—Skull of *Feroculus feroculus* × 3

Fur. Close, very soft and moderately short, densely clothing the head and body ; short and fine upon the muzzle and ears ; very short, fine and scanty on the feet which are semi-naked : fine and scanty but

intermixed with a few long hairs on the tail; whiskers numerous and long.

Colour. General colour uniform slaty or ashy black on the upper parts; paler slaty on the underparts; chin rather greyish; feet fleshy grey with the short hairs dark grey; tail dusky with the extreme tip whitish; whiskers grey; claws whitish.

Measurements. Body measurements, taken from the specimen in spirits.

Male. Length, head and body, 118 mm., tail 72 mm., hind foot 20 mm., fore foot 12 mm., ear 10 mm., head and snout 36 mm. The longest claw on the fore foot measures 6 mm.

Skull. The measurements of the skull, which has been described by Dr. Kelaart when describing the genus, are as follows:

Greatest length 27 mm., condylo–incisive length 28 mm., breadth across molars 7·5 mm., intraorbital breadth 6·5 mm., mastoid breadth 12·5 mm., dental length 11 mm., front 2p.m. to back 4m. 6 mm., length upper incisors 2·6 mm., length lower incisors 4 mm.

Mr. W. E. Wait is to be congratulated upon having found and preserved this very interesting specimen.

A Check list of the Mammals of Ceylon

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

WITH ONE MAP

The present writer published in 1923 (Spolia Zeylanica, Vol. XII, Pt. 46. May 30th, 1923) a provisional list of the Mammals of Ceylon, giving, as well as the names, the standing of each form as then known from the Island. Since that year so many new forms have been discovered and so many changes in nomenclature have been made, that this list is no longer accurate. It is now, therefore, fully revised ; all the recently discovered species and sub-species are included and the present day nomenclature, chief synonym, the popular and vernacular names, the type locality and the distribution of each form is given.

Synonyms. For the sake of brevity, I have given only the most important of the scientific synonyms. As far as possible I have included only the original name, that given by Dr. Kelaart in " Prodromus Faunae Zeylanicus," the most important work on Ceylon Mammals, and that given by Dr. Blanford in the Mammalian Volume of the Fauna of British Indian Series, the standard work. In some cases, however, one or two additional synonyms are so important that I have not been able to omit them.

Vernacular names. The Tamil and Sinhalese names are given where known ; these are the names as given to me, in most cases, by the estate labourers and local villagers. I have spelt them phonetically as far as I am able.

Distribution. In most cases where a species or sub-species is not found throughout the whole Island its range is restricted by climatic conditions to a definite tract or tracts. Many forms are found in the Hills and not in the Low-country and *vice versa* ; others are found in

one part of the Low-country and not in the other—and of some species several geographical races or sub-species exist, each race being found in a different part of the Island, under different conditions of climate induced by altitude or rainfall.

Broadly speaking, the Island is divisible into three definite climatic tracts or zones, each of which has a fauna and flora differing in many respects from those of the other two. In many cases the forms found in a given zone are peculiar to it and are not found in the remainder of the Island.

Low-country Dry Zone. This tract, which is the largest in area, comprises roughly the whole of the northern half of the Island (that is to say the North-Western Province, the Northern Province, the North-Central Province. a small piece of the Central Province as far south as about Nalanda, and the Eastern Province). all the Low-country part of the Uva Province in the East and the eastern half of the Southern Province, to between Tangalla and Matara on the south coast. In this tract, it should be noted, the general fauna is closely akin to, and in many cases identical with, the fauna of the neighbouring coasts of the Indian Mainland. This zone is chiefly flat jungle country for the most part sparcely populated ; it has an annual rainfall to about 60 inches, most of which falls during the North-East monsoon.

Low-country Wet Zone. This is a much smaller tract ; it comprises a small area of broken country and low hills lying to the south west of the central mountain cluster. Roughly it includes the Western Province, Province of Sabaragamuwa and the Southern Province as far east as an indefinite line, where it meets the Dry Zone, between Matara and Tangalla. This zone is chiefly composed of low hills and broken country, in which are situated the chief Rubber producing districts ; it has a well distributed annual rainfall to 200 inches.

Central Hill Zone. This tract comprises the central mountain cluster situated in the Central and Uva Provinces. It comprises mountainous and upland country, to an altitude of 7,000/8,000 ft. ; it has an annual rainfall of over 200 inches in some parts but considerably less in others.

The accompanying map shows the approximate position and area of each zone.

Order PRIMATES

Sub-order ANTHROPOIDEA

Family Cercopithecidae

Genus MACACA

(No. 1). Macaca sinica

The Toque Monkey

1771.	*Simia sinica*	Linneaus, (Syst. Nat.) Mantissa, p. 521
1852.	*Macacus sinicus*	Kelaart, Prod. Faun. Zeyl., p. 8.
1888.	*Macacus pileatus*	Blanford, Mammalia, No. 11.

Popular names. The Red Monkey; Sinhalese, Rilawa; Tamil, Kurangu.

Distribution. Type locality, unknown; species peculiar to Ceylon; common in the jungles throughout the Island.

Genus PITHECUS

(No. 2). Pithecus entellus pallipes

The Madras Langur

1844.	*Semnopithecus pallipes*	Blyth, A. & M.N.H., p. 312
1852.	*Presbytes priamus*	Kelaart, Prod. Faun. Zeyl., p. 3.
1888.	*Semnopithecus priamus*	Blanford, Mammalia, No. 14.

Popular names. The Grey Wanderoo; Sinhalese, Wandura or Konde Wandura; Tamil, Mundi.

Distribution. Type locality, "Coromandel Coast, India"; common in parts of South India; common throughout the Low- country Dry Zone.

Pithecus senex

Four races of this species are found in different parts of the Island, both in the Hills and in the Low-country. The typical race *P. s. senex*, seems to have been founded on an albino.

(No. 3). Pithecus senex vetulus

The Purple Faced Monkey

1777.	*Cercopithecus vetulus*	Erxleben, Syst. R.A.M. 3., p. 25.
1852.	*Presbytes cephalopterus*	Kelaart, Prod. Faun. Zeyl., p. 1.
1888.	*Semnopithecus cephalopterus*	Blanford, Mammalia, No. 17.

Popular names. The Black Wanderoo; Sinhalese, Kaloo wandura or Wandura; Tamil, Mundi.

Distribution. Type locality, "East Indies," sub-species peculiar to Ceylon ; common in the jungles of the Galle, Kalutara and Ratnapura districts—the Low-country Wet Zone, south of the Kaluganga (River).

(No. 4). Pithecus senex nestor

1833.	*Semnopithecus nestor*	Bennett, P.Z.S., p. 67.
1876.	*Semnopithecus kelaarti*	Schlegel, Monogr. des Singes., p. 52.
1888.	*Semnopithecus cephalopterus*	Blanford, Mammalia, No. 17. (partim)
1923.	*Pithecus vetulus phillipsi*	Hinton, A. & M.N.H., Ser. 9, Vol. XI.

Popular names. The Wanderoo; Sinhalese, Wandura; Tamil, Mundi.

Distribution. Type locality, unknown (probably Rayigam), (W.P.); sub-species peculiar to Ceylon ; moderately common in the jungles of the Kelani Valley, Colombo, Panadura and Veyangoda districts—the Low-country Wet Zone, north of the Kaluganga (River).

(No. 5). Pithecus senex monticola

The Bear Monkey

1850.	*Presbytis cephalopterus var. monticola*	Kelaart, J R.A.S. (Ceyl.), 11, No. 5, p. 321
1852.	*Presbytis ursinus*	Kelaart, Prod. Faun. Zeyl., p. 2.
1888.	*Semnopithecus ursinus*	Blanford, Mammalia, No. 19.

Popular names. The Up-country Wanderoo : Sinhalese, Maha wandura ; Tamil, Mundi.

Distribution. Type locality Nuwara Eliya (C.P.), sub-species peculiar to Ceylon ; confined to the highland jungles of the Central Hill Zone above an altitude of about 4,000 ft.; this race is becoming more uncommon each year.

(No. 6). Pithecus senex philbricki

The Kantalai Dusky Langur

1926.	*Pithecus philbricki*	Phillips, C.J. of S. Sec. B. XIV, Pt. 1.

Popular names. The Kantalai Black Wanderoo ; Sinhalese, Kaloo wandura ; Tamil Mundi.

Distribution. Type locality, Kantalai Tank (E.P.), Ceylon ; sub-species peculiar to Ceylon ; not uncommon in the jungles around Kantalai Tank, in the Eastern Province (Low-country Dry Zone).

Sub-order LEMUROIDEA

Family Lemuridae

Genus LORIS

(No. 7). Loris tardigradus

The Ceylon Slender Loris

1766.	*Lemur tardigradus*	Linneaus, Syst. Nat., p. 44.
1852.	*Stenops gracilis*	Kelaart, Prod. Faun. Zeyl., p. 9.
1888.	*Loris gracilis*	Blanford, Mammalia, No. 27.

Popular names. The Ceylon Sloth ; Sinhalese, Unahapuluva; Tamil, Thevangu.

Distribution. Type locality, " Ceylon " ; species peculiar to Ceylon ; found sparingly over the greater part of the Low-country and in the lower hills of the Central Province, to an altitude of about 1,500 ft.

Order CHIROPTERA

Sub-order MEGACHIROPTERA

Family Ptéropidae

Genus ROUSETTUS

(No. 8). Rousettus seminudus

The Ceylon Fruit Bat

1850.	*Pteropus seminudus*	Kelaart, J.R.A.S. (Ceyl.), 11, No. 5, p. 329
1852.	*Pteropus seminudus*	Kelaart, Prod. Faun. Zeyl., p. 27.
1891.	*Xantharpyia amplexicaudata*	Blanford, Mammalia, No. 137.

Popular names. The Fruit Bat ; Sinhalese Wawula ; Tamil, Vava.

Distribution. Type locality, Mount Lavinia (W.P.), Ceylon ; species peculiar to Ceylon; common locally in many parts of the Low-country and in the hills of the Central Province to about 3,000 ft.

Genus PETROPUS

(No. 9). Petropus giganteus giganteus

The Common Flying Fox

1782.	*Vespertilio gigantea*	Brunnich, Dyrenes Historie, I., p. 45.
1852.	*Petropus edwardsii*	Kelaart, Prod. Faun. Zeyl., p. 27.
1891.	*Petropus medius*	Blanford, Mammalia, No. 134.

Popular names. The Flying Fox ; Sinhalese, Maha wawula or Loco wawula; Tamil, Periya vava.

Distribution. Type locality, "Bengal"; common in many parts of the Indian Peninsula; very common, locally, in many districts in the Island and resident in the hills to about 2,000 ft. altitude.

Genus CYNOPTERUS

(No. 10). Cynopterus brachyotus ceylonensis.

The Ceylon Short Nosed Fruit Bat

1852.	*Cynopterus marginatus*	Kelaart, Prod. Faun. Zeyl., p. 28.
1891.	*Cynopterus marginatus*	Blanford, Mammalia, No. 138, (partim)
1899.	*Cynopterus spinx ceylonensis*	Matschie, ?

Popular names. The small Fruit Bat; Sinhalese, Yak wawula or wawula; Tamil, Vava.

Distribution. Type locality, Pundaluoya (C.P.), Ceylon; sub-species peculiar to Ceylon; common over the greater part of the Island and resident in the hills to an altitude of 6,000 ft.

Sub-order MICROCHIROPTERA

Family Rhinolophidae

Genus RHINOLOPHUS

(No. 11). Rhinolophus rouxi rouxi

The Rufous Horse-shoe Bat

1835.	*Rhinolophus rouxi*	Temminck, Mon. Mammalia, 11, p. 30.
1852.	*Rhinolophus rubidus, cinerascens and rammanika*	Kelaart, Prod. Faun. Zeyl., p. 13.
1891.	*Rhinolophus affinis*	Blanford, Mammalia, No. 150.

Popular names. The Horse-shoe Bat; Sinhalese, Kiri wawula or (sometimes) Kotican wawula; Tamil, Vava.

Distribution. Type locality, Pondicherry and Calcutta; common throughout a great part of India; very common all over the Low-country and lower hills, to an altitude of about 4,000 ft.

(No. 12). Rhinolophus beddomei sobrinus

The Great Indian Horse-shoe Bat

1891.	*Rhinolophus luctus*	Blanford, Mammalia, No. 145. (partim)

Popular names. The Horse-shoe Bat; Sinhalese, Kotican wawula; Tamil, Vava.

Distribution. Type locality, (?); found in some districts of Southern India; a rare bat in Ceylon, found occasionally in some of the Low-country jungles.

Genus HIPPOSIDEROS

(No. 13). Hipposideros lankadiva

The Large Indian Leaf-nosed Bat

1852.	*Hipposideros lankadiva*	Kelaart, Prod. Faun. Zeyl., p. 19.
1891.	*Hipposideros diadema*	Blanford, Mammalia, No. 161. (partim)

Popular names. The Leaf-nosed Bat ; Sinhalese, Kotican wawula ; Tamil, Vava.

Distribution. Type locality, Kandy (C.P.), Ceylon ; found in Southern India ; common, locally, in one or two places in the lower hills of the Central Province, to an altitude of about 2,000 ft.

(No. 14). Hipposideros speoris speoris

Sykes' Leaf-nosed Bat

1813.	*Vespertilio speoris*	Schneider, Schreber, Saugth Supp., p. 159B.
1852.	*Hipposideros templetonii, aureus, blythii*	Kelaart, Prod. Faun. Zeyl. p. 17 & 20.
1891.	*Hipposideros speoris*	Blanford, Mammalia, No. 164.

Popular names. The Leaf-nosed Bat ; Sinhalese, Kiri wawula or Podi wawula ; Tamil, Sinna vava.

Distribution. Type locality, Timor and Amboina, India ; found over most of Southern India ; common over most of the Low-country.

(No. 15). Hipposideros brachyotus

The Dekhan Leaf-nosed Bat

1874.	*Phyllorhina brachyota*	Dobson J.A.S.B. XLIII, Pt. 2, p. 237.
1891.	*Hipposideros galeritus*	Blanford, Mammalia, No. 163.

Popular names. The Leaf-nosed Bat ; Sinhalese, Kiri wawula or Podi wawula Tamil, Sinna vava.

Distribution. Type locality, ' Central India " ; occurs in parts of the Indian Peninsular ; not uncommon in the Low-conntry and lower hills, to an altitude of about 3,000 ft.

(No. 16). Hipposideros atratus.

The Ceylon Bicoloured Leaf-nosed Bat

1852.	*Hipposideros atratus*	Kelaart, Prod. Faun. Zeyl., p. 15.
1852.	*Hipposideros fulvus* and *murinus*	Kelaart, Prod. Faun. Zeyl. p. 15.
1891.	*Hipposideros bicolor*	Blanford, Mammalia, No. 166 (partim)

Popular names. The little Leaf-nosed Bat ; Sinhalese, Kiri wawula ; Tamil, Sinna vava.

Distribution. Type locality, Colombo (W.P.); species peculiar to Ceylon; common throughout most of the Low-country and lower hills, to an altitude of about 2,000 ft.

Family **Megadermatidae**

Genus **MEGADERMA**

(No. 17). **Megaderma spasma ceylonensis**

The Ceylon Vampire Bat

1891.	*Megaderma spasma*	Blanford, Mammalia, No. 170.
1921.	*Megaderma spasma ceylonensis*	?

Popular names. The Long-eared Bat; Sinhalese, Tutica wawula, or Kotican wawula; Tamil, Vava.

Distribution. Type locality, (?) ; sub-species peculiar to Ceylon; common locally, in some parts of the Low-country, especially in the Kalutara District of the Wet Zone.

Genus **LYRADERMA**

(No. 18). **Lyraderma lyra lyra**

The Indian Vampire Bat

1810.	*Megaderma lyra*	Geoffroy, Ann. Mus. XV., p. 190.
1852.	*Megaderma lyra*	Kelaart, Prod. Faun. Zeyl., p. 11.
1891.	*Megaderma lyra*	Blanford, Mammalia, No. 169.

Popular names. The Long-eared Bat; Sinhalese, Tutican wawula or Kotican wawula; Tamil, Vava.

Distribution. Type locality, "East coast of Madras,": found in many parts of India; fairly common, locally, in the Colombo and Kalutara districts, and in one or two other places on the West Coast.

Family **Vespertilionidae**

Sub-family **Vespertilioninae**

Genus **PIPISTRELLUS**

(No. 19). **Pipestrellus ceylonicus ceylonicus**

Kelaart's Bat

1852.	*Scotophilus ceylonicus*	Kelaart, Prod. Faun. Zeyl., p. 22.
1891.	*Vesperugo ceylonicus*	Blanford, Mammalia, No. 186.

Popular names. Sinhalese, Kiri wawula or Podi wawula; Tamil, Sinna vava.

Distribution. Type locality, "Ceylon"; sub-species peculiar to Ceylon; very common throughout the Central Hill Zone to an altitude of 7,000 ft.; is also found, less commonly, in the Low-country Wet Zone.

(No. 20). Pipistrellus coromandra

The Coromandel Pipistrelle

1838.	*Scotophilus coromandra*	Gray, Mag. Zool. Bot. 11, p. 498.
1852.	*Scotophilus coromandelicus*	Kelaart, Prod. Faun. Zeyl., p. 21 (partim)
1891.	*Vesperugo abramus*	Blanford, Mammalia, No. 18 (partim)

Popular names. The Little Bat; Sinhalese, Kossetta wawula; Tamil, Sinna vava.

Distribution. Type locality, Coromandel Coast, India; common in many parts of India; common in Ceylon, throughout the Low-country Dry Zone.

(No. 21). Pipistrellus mimus mimus

The Southern Dwarf Pipistrelle

1852.	*Scotophilus coromandelicus*	Kelaart, Prod. Faun. Zeyl., p. 21 (partim)
1891.	*Vesperugo abramus*	Blanford, Mammalia, No. 187 (partim)
1899.	*Pipistrellus mimus*	Wroughton, J.B.N.H.S., Vol XII., p. 722

Popular names. The Little Bat; Sinhalese, Kossetta wawula; Tamil, Sinna vava

Distribution. Type locality, Inheskatri, Surat Dangs, India; common in many parts of India; very common throughout the Low-country Wet Zone, and the lower hills of the Central Province to about 2,000 ft.

Genus HESPEROPTENUS

(No. 22). Hesperoptenus tickelli

Tickell's Bat

1851.	*Nycticejus tickelli*	Blyth, J.A.S.B. Vol. XX. p. 157.
1852.	*Nycticejus tickelli*	Kelaart, Prod. Faun. Zeyl. p. 24.
1891.	*Vesperugo tickelli*	Blanford, Mammalia No. 191.

Popular names. The Golden Bat, Sinhalese Podi wawula or Kiri wawula; Tamil Sinna vava.

Distribution. Type locality, Chaibassa (Central India); found in many parts of India; common, but somewhat local, throughout the Low-country; found in the hills to 3,000 ft

Genus **SCOTOPHILUS**

(No 23. **Scotophilus kuhli**

The Common Yellow Bat

1822.	*Scotophilus kuhli*	Leach, Tr. L.S. XIII. p. 72.
1852.	*Nycticejus heathii* and *belanegri*	Kelaart, Pro. Faun. Zeyl. p. 23.
1891.	*Nycticejus kuhli*	Blanford, Mammalia, p. 94.

Popular names. Sinhalese, Podi wawula; Tamil, Vava.

Distribution. *Type locality*, unknown; common throughout India; very common, locally, in many parts of the Low-country and in the hills, to about 2,000 ft.

(No. 24). **Scotophilus wroughtoni**

Wroughton's Bat

1897.	*Scotophilus wroughtoni*	Thomas, J.B.N.H.S., XI. p. 274.

Popular names. Sinhalese, Podi wawula: Tamil, Sinna vava.

Distribution. *Type locality*, Kim, Surat (India); common in many parts of the plains of India; obtained at Anuradhapura in 1914; possibly not uncommon in the northern part of the Low-country Dry Zone.

Genus **LEUCONOE**

(No. 25). **Leuconoe hasselti**

Van Hasselt's Bat

1840.	*Vespertilio hasselti*	Temminck, Mon. Mammalia, p. 225.
1891.	*Vespertilio hasselti*	Blanford, Mammalia, No. 203.

Popular names. Sinhalese, Podi wawula; Tamil, Sinna vava.

Distribution. *Type locality*, Java: found in the Malay Peninsula, Sumatra and Java; has been found in several places in the Low-country Dry Zone, in Ceylon.

Sub-family Kerivoulinae

Genus **KERIVOULA**

(No. 26). **Kerivoula picta**

The Painted Bat

1767.	*Vespertilio pictus*	Pallas, Spic. Zool. fasc. iii. p. 7.
1852.	*Kerivoulha picta*	Kelaart, Prod. Faun. Zeyl. p. 25.
1891.	*Cerivoula picta*	Blanford, Mammalia, No. 213.

Popular names. The Red or Painted Bat; Sinhalese, Kiri wawula; Tamil, Sinna vava.

Distribution. Type locality, " Peninsula of India " ; has been found in many parts of India and Burma ; is found, occasionally, in many parts of the Low-country and in the hills to about 4,000 ft.

Sub-family Miniopterinae

Genus MINIOPTERUS

(No. 27). Miniopterus fuliginosus

The Long Winged Bat

1835.	*Vespertilio fuliginosa*	Hodgson, J.A.S.B. IV. p. 700.
1891.	*Miniopterus schreibersi*	Blanford, Mammalia, No. 216.

Popular names. Sinhalese, Kiri wawula ; Tamil, Sinna vava.

Distribution. Type locality, Nepal, North India ; common in parts of India ; very common, locally, in the drier foothills, to an altitude of about 3,500 ft.

Family Emballonuridae

Sub-family Emballonurinae

Genus TAPHOZOUS

(No. 28). Taphozous longimanus

The Long-armed Sheath-tailed Bat

1823.	*Taphozous longimanus*	Hardwicke, Tr.L.S. XIV. p. 525.
1852.	*Taphozous longimanus* and *brevicaudus*	Kelaart, Prod. Faun. Zeyl. p. 12.
1891.	*Taphozous longimanus*	Blanford, Mammalia, No. 220.

Popular names. Sinhalese, Podi wawula ; Tamil, Vava.

Distribution. Type locality, Calcutta ; found in many parts of India ; not uncommon in the Western and Eastern Provinces in Ceylon ; and most probably in other parts of the Low-country as well.

(No. 29). Taphozous melanopogon

The Black-bearded Sheath-tailed Bat

1841.	*Taphozous melanopogon*	Temminck, Mon. Mam. II. p. 287.
1891.	*Taphozous melanopogon*	Blanford, Mammalia, No. 218.

Popular names. Sinhalese, Podi wawula Tamil, Vava.

Distribution. Type locality, Java ; well distributed throughout the greater part of India and Burma in Ceylon, one or two colonies have been found in the Kalutara district of the Western Province. (Low-country Wet Zone).

Genus **SACCOLAIMUS**

(No. 30). **Saccolaimus saccolaim**

The Pouch-bearing Sheath-tailed Bat

1835.	*Taphozous saccolaimus*	Temminck, Mon. Mam. II. p. 285.
1891.	*Taphozous saccolaemus*	Blanford, Mammalia, No. 222.

Popular names. Sinhalese, Podi wawula ; Tamil, Sinna vava

Distribution. *Type locality,* Java ; found in many parts of India, Burma, the Malay Peninsula, Java and Sumatra ; common over most of the Low-country and found occasionally in the drier foothills, to about 3,500 ft. altitude.

Order INSECTIVORA

Family **Soricidae**

Genus **FEROCULUS**

(No. 31). **Feroculus feroculus**

Kelaart's Long-clawed Shrew

1850.	*Sorex feroculus*	Kelaart, J.R.A.S. (Ceylon) 11. p. 325.
1852.	*Feroculus macropus*	Kelaart, Prod. Faun. Zeyl. p. 32.
1888.	*Crocidura macropus*	Blanford, Mammalia, No. 119.

Popular names. The Mole Shrew ; Sinhalese, Hik-miya or Kuni-miya ; Tamil, Mungi' elli.

Distribution. *Type locality,* Nuwara Eliya (C P.) ; genus and species peculiar to Ceylon ; rare, known only from the type locality and from the Horton Plains (7,000 ft.) in the Central Hill Zone.

Genus **SUNCUS**

(No. 32). **Sunus caeruleus**

The Grey Musk Shrew

1792.	*Sorex caeruleus*	Kerr. An. King. p. 207.
1852.	*Sorex murinus*	Kelaart, Prod. Faun. Zeyl. p. 30.
1888.	*Crocidura caerulea*	Blanford, Mammalia, No. 118.

Popular names. The Musk-rat or Musk-shrew ; Sinhalese, Hik-miya or Kuni-miya ; Tamil, Mungi' elli.

Distribution. *Type locality,* Java (?) ; common in towns and around human habitations throughout India and Burma generally ; common in Kandy, Colombo, Galle and other large towns and sea ports,

(No. 33). Suncus murinus kandianus

The Kandyan Shrew

1852.	*Sorex kandianus*	Kelaart, Prod. Faun. Zeyl. p. 30.
1888.	*Crocidura murina*	Blanford, Mammalia, No. 117 (partim)
1928.	*Suncus murinus kandianus*	Phillips. C. J. of S. Sec. B. XIV. p. 305.

Popular names. The Shrew–mouse ; Sinhalese, Hik–miya or Kuni–miya ; Tamil Mungi' elli.

Distribution. Type locality, Kandy (C.P.) ; sub–species peculiar to Ceylon ; not uncommon, at a medium altitude (500'2,500 ft.), in the dryer districts of the Central Hill Zone. Possibly found also to sea level in the Eastern Province.

Suncus montanus

The Highland Shrew

Two races of this Shrew are found in different parts of the Central Hill Zone.

(No 34). Suncus montanus montanus

The Ceylon Highland Shrew

1850.	*Sorex montanus*	Kelaart, J.R.A.S. (Ceylon) 11. p. 324.
1852.	*Sorex montanus*	Kelaart, Prod. Faun. Zeyl. p. 32.
1888.	*Crocidura murina*	Blanford, Mammalia, No. 117 (partim)

Popular names. The Black Shrew–mouse ; Sinhalese, Kuni–miya or Hik–miya; Tamil, Mungi' elli.

Distribution. Type locality, Nuwara Eliya (C.P.) ; sub–species peculiar to Ceylon ; common in the Central Hill Zone above 3,000 ft. and also found in the low hills towards Galle, in the Low–country Wet Zone.

(No. 35). Suncus montanus ferrugineus

The Brown Highland Shrew

1850.	*Sorex ferrugineus*	Kelaart, J.R.A.S. (Ceylon) 11. p. 325.
1852.	*Sorex ferrugineus*	Kelaart, Prod. Faun. Zeyl. p. 185.
1888.	*Crocidura murina*	Blanford, Mammalia, No. 117 (partim)

Popular names. The Brown Shrew–mouse ; Sinhalese Hik–miya or Kuni–miya ; Tamil, Mungi' elli.

Distribution. Type locality, " Dimbula " (C.P.) : sub–species peculiar to Ceylon; rare, found occasionally in the Central Hill Zone above 4,500 ft.; has been recorded from Dimbu a, Maskeliya and Pattipola.

(No. 36). Suncus zeylanicus

The Ceylon Jungle Shrew

1928.	*Suncus zeylanicus*	Phillips, C.J. of S., Sec. B. XIV. p. 311.

Popular names. Sinhalese, Kuni–miya ; Tamil, Mungi' elli.

Distribution. Type locality, Kitulgala (Sab.) ; species peculiar to Ceylon ; known only from the type locality, where it is found occasionally in the jungles.

(No. 37). Suncus perrotteti.

The Indian Pigmy Shrew

1842.	*Sorex perrotteti*	Duvernoy, Mag. Zool. p. 29.
1888.	*Crocidura perrotteti*	Blanford, Mammalia, No. 125.

Popular names. Sinhalese, Podi Hik–miya or Podi Kuni–miya ; Tamil, Sinna Mungi' elli or Mungi' elli kutti.

Distribution. Type locality, Nilgiris, South India ; found n the hills of Southern India . in Ceylon is known only fro n Mousakande Estate, Gammaduwa, in the East Matale Hills.

Genus CROCIDURA

(No. 38). Crocidura kelaarti

1855.	*Sorex kelaarti*	Blyth, J.A.S.B. XXIV. p. 32.
1888.	*Sorex kelaarti*	Blanford, Mammalia, p. 244.

Popular names. Shrew–mouse : Sinhalese, Podi Hik–miya or Podi Kuni–miya : Tamil, Sinna Mungi' elli.

Distribution. Type locality, Galle (C.P.) ; species peculiar to Ceylon ; reported as being not uncommon in parts of the Southern Province

(No. 39). Crocidura horsfieldi

Horsfield's Shrew

1856.	*Sorex horsfieldi*	Tomes, A. & M.N.H. Ser. 2. XVII. p. 23
1888.	*Crocidura horsfieldi*	Blanford, Mammalia, No. 127.

Popular names. Sinhalese, Podi Hik–miya or Podi Kuni–miya ; Tamil, Sinna Mungi' elli or Mungi' elli kutti.

Distribution. Type locality, Peradeniya (C.P.) ; species peculiar to Ceylon; rare, known only from Peradeniya and Galaha, in the Kandyan Hills ; is possibly found throughout the Kandyan Hills, at an altitude between 1,500 and 3,500 ft.

(No. 40). Crocidura miya

1928. *Crocidura miya* Phillips, C.J. of S. Sec. B. XV. p. 113

Popular names. Sinhalese, Hik–miya or Kuni–miya Tamil, Mungi' elli.

Distribution *Type locality,* Moolgama, near Galaha, Kandyan Hills; species peculiar to Ceylon; known only from the type locality, where it appears to be very rare

Genus SOLISOREX

(No. 41). Solisorex pearsoni

Pearson's Shrew

1924. *Solisorex pearsoni* Thomas, C.J. of S. Sec B. XIII. p. 95.

Popular names. The Mole–Shrew, Sinhalese, Hik–miya or Kunu-miya; Tamil Mungi' elli.

Distribution. *Type locality* Hakgala, near Nuwara Eliya, genus and species peculiar to Ceylon; known only from the Nuwara Eliya district, where it is very uncommon; is most probably confined to the highest altitudes (6,000 ft. and over) in the hills of the Central Province.

Order CARNIVORA

Sub–order FISSIPEDIA

Section AELUROIDEA

Family Felidae

Genus FELIS

(No. 42). Felis pardus

The Leopard or Panther

1766. *Felis pardus* Linnaeus, Syst. Nat. I, p. 61.
1852. *Felis leopardus* Kelaart, Prod. Faun. Zeyl. p. 45.
1888. *Felis pardus* Blanford, Mammalia, No. 30.

Popular names. The Leopard; Sinhalese, Kotiya (general term), Diviya (male) Dividena (female); Tamil, Pilli.

Distribution. *Type locality,* Egypt; found throughout most parts of Asia, except in Siberia and Asia Minor; common, in suitable country, throughout the Island.

(No. 43). Felis viverrina

The Fishing Cat.

1833.	*Felis viverrina*	Bennett, P.Z.S. p. 68.
1852.	*Felis viverriceps*	Kelaart. Prod. Faun. Zeyl. p. 46.
1888.	*Felis viverrina*	Blanford, Mammalia, No. 35.

Popular names. The Tiger Cat; Sinhalese, Andhun-diviya or Kolla-diviya; Tamil, Koddy-pilli.

Distribution. Type locality, Madras Presidency; found in many parts of India; occurs sparingly, in the jungles throughout the Island.

(No. 44). Felis rubiginosa

The Rusty Spotted Cat

1834.	*Felis rubiginosa*	Belanger, Voy. Or. Zoologie, p. 141.
1852.	*Felis rubiginosa*	Kelaart, Prod. Faun. Zeyl. p. 47.
1888.	*Felis rubiginosa*	Blanford, Mammalia, No. 37.

Popular names. The Small Jungle Cat; Sinhalese, Wal-balala; Tamil, Kadu-poona.

Distribution. Type locality, "Pondicheri, Madras"; occurs in certain parts of the Indian Peninsular; found throughout the jungles of the Island.

(No. 45). Felis affinis

The Jungle Cat

1830.	*Felis affinis*	Gray, Hardwicke's Ill. Ind. Zool. I. pl. ii.
1852.	*Felis chaus*	Kelaart, Prod. Faun. Zeyl. p. 48.
1888.	*Felis chaus*	Blanford, Mammalia, No. 41.

Popular names. The Jungle Cat or Wild Cat; Sinhalese, Wal-balala or Kolla-diviya; Tamil, Kadu-poona.

Distribution. Type locality, Gangutri, Kumaon; found over the greater part of India, Persia and Burma; confined to the Low-country Dry Zone, but not common anywhere.

Family Viverridae

Sub-family Viverrinae

Genus VIVERRICULA

(No. 46). Viverricula malaccensis

The Small Indian Civet Cat

1788.	*Viverra malaccensis*	Gmelin, Syst. Nat. 1. p. 92.
1852.	*Viverricula malaccensis*	Kelaart, Prod. Faun. Zeyl. p. 37.
1888.	*Viverricula malaccensis*	Blanford, Mammalia, No. 48.

Popular names. The Civet Cat; Sinhalese, Urulaeva; Tamil, Poolu poona, sometimes Veeregu,

Distribution. *Type locality,* " in India " ; found in many parts of India, Burma and Malay ; common, in suitable country, throughout the whole Island.

Genus **PARADOXURUS**

(No. 47). **Paradoxurus niger**

The Indian Toddy Cat

1820.	*Viverra nigra*	Desmarest, Mam. p. 208.
1852.	*Paradoxurus typus*	Kelaart, Prod. Faun. Zeyl. p. 38.
1888.	*Paradoxurus niger*	Blanford, Mammalia, No. 51.

Popular names. The " Polecat" or The Black Palm Cat ; Sinhalese Uggudiuwa (sometimes Kalawedda) ; Tamil, Marum nai.

Distribution. *Type locality,* Pondicheri, India ; common throughout Central and Southern India ; common, in suitable country, throughout almost the whole Island but uncommon, locally, in one or two places.

(No. 48). **Paradoxurus aureus**

The Ceylon Palm Civet

1822.	*Paradoxurus aureus*	F. Cuvier, Mem. Mus. Hist. Nat. ix, p. 48.
1852.	*Paradoxurus zeylanicus* and *montanus*	Kelaart, Prod. Faun. Zeyl. p. 39/40.
1888.	*Paradoxurus aureus*	Blanford, Mammalia, No. 53.

Popular names. Golden Palm Cat or Red Palm Cat ; Sinhalese, Kalawedda. Tamil, Segapie Marum nai, often Kalawedda.

Distribution. *Type locality* " Ceylon " ; species peculiar to Ceylon; locally distributed but common in many districts in the Central Hill Zone ; has been found occasionally in the Ratnapura district and also in the North-Central Province in the Low-country.

Sub-family **Herpestinae**

Genus **HERPESTES**

(No. 49). **Herpestes lanka**

The Common Ceylon Mongoose

1852.	*Herpestes griseus*	Kelaart, Prod. Faun. Zeyl. p. 41.
1888.	*Herpestes mungo*	Blanford, Mammalia, No. 60 (partim.)
1915.	*Mungos lanka*	Wroughton, J.B.N.H.S. Vol. XXIV. p. 53.

Popular names. Grey or Silver Mongoose ; Sinhalese, Mugatiya ; Tamil, Kiri or Kiri-pullie.

Distribution. *Type locality,* Cheddikulam (N.P.), Ceylon ; species peculiar to Ceylon ; common throughout, and confined to, the Low-country Dry Zone.

(No. 50). Herpestes flavidens

The Ceylon Brown Mongoose

Five local races of this species have been described from different parts of the Island.

(No. 51). Herpestes flavidens flavidens

1852.	*Herpestes flavidens*	Kelaart, Prod. Faun. Zeyl. p. 44.
1888.	*Herpestes fulvescens*	Blanford, Mammalia, No. 63.
1924.	*Herpestes flavidens flavidens*	Thomas, A. & M.N.H. Ser. 9. Vol. XIII. p. 239.

Popular names. Brown Mongoose; Sinhalese, Mugatiya or Ram-mugatiya; Tamil, Kiri-pulle or Karrang-kiri.

Distribution, Type locality, Kandy (C.P.), Ceylon; sub-species peculiar to Ceylon; fairly common around Kandy and in the Central Hill Zone, generally; has been recorded from Nuwara Eliya (6,188 ft.) and Pattipola (6,210 ft.)

(No. 52). Herpestes flavidens phillipsi

1924.	*Herpestes flavidens phillipsi*	Thomas, A. & M.N.H. Ser 9. Vol. XIII. p. 239.

Popular names. Brown Mongoose; Sinhalese, Mugatiya; Tamil, Kiri-pullie or Poo-thingaratha-kiri.

Distribution. Type locality, Mousakande, Gammaduwa (C.P.), Ceylon; sub-species peculiar to Ceylon; not uncommon in the neighbourhood of Mousakande Estate, in the East Matale hills.

(No. 53). Herpestes flavidens maccarthiae

1852.	*Cynictis maccarthiae*	Gray, P.Z.S. 1851 p. 131.
1924.	*Herpestes flavidens maccarthiae*	Thomas A. & M.N.H. Ser. 9. Vol. XIII. p. 239.

Popular names. Brown Mongoose; Sinhalese, Mugatiya; Tamil, Kiri or Kiri-pullie.

Distribution. Type locality, unknown; sub-species peculiar to Ceylon; common throughout the Kalutara district and the Low-country Wet Zone generally.

(No. 54). Herpestes flavidens ceylonicus

?	*Herpestes ceylonicus*	H. Nevill, Taprobanian, 1. p. 62.
1924.	*Herpestes flavidens ceylonicus*	Thomas, A. & M.N.H. Ser. 9. Vol. XIII.

Popular names. Brown Mongoose; Sinhalese, Mugatiya; Tamil, Kiri or Kiri-pullie.

Distribution. Type locality, Trincomalie, Ceylon ; sub-species peculiar to Ceylon. ; has been recorded from Trincomalie in the Eastern Province and Kumbukkan in Uva ; is probably not uncommon in many parts of the Low-country Dry Zone.

(No. 55). Herpestes flavidens siccatus

1924.	*Herpestes flavidens siccatus*	Thomas, A. & M.N.H. Ser. 9. Vol. XIII. p. 240.

Popular names. Brown Mongoose ; Sinhalese, Mugatiya ; Tamil, Kiri or Kiri-pullie.

Distribution. Type locality, uncertain, probably Aripo, North Ceylon ; sub-species peculiar to Ceylon ; believed to be found around Aripo and Mannar in the Northern Province.

(No. 56). Herpestes smithii zeylanicus

The Ceylon Ruddy Mongoose

1852.	*Herpestes rubiginosus*	Kelaart, Prod. Faun. Zeyl. p. 43.
1888.	*Herpestes smithi*	Blanford, Mammalia, No. 61.
1921.	*Herpestes smithii zeylanicus*	Thomas, J.B.N.H.S. Vol. XXVIII. p. 24.

Popular names. Red Mongoose ; Sinhalese, Hotamba ; Tamil, Kiri or Seng-kiri.

Distribution. Type locality, Mankeni (E.P.), Ceylon ; sub-species peculiar to Ceylon ; common throughout most parts of the Low-country, especially in the Wet Zone ; in the hills it is not as common as in the Low-country, but it is occasionally seen to an altitude of about 3,500 ft.

(No. 57). Herpestes vitticollis

The Striped-necked Mongoose

1835.	*Herpestes vitticollis*	Bennett, P.Z.S. 1835. p. 67.
1852.	*Herpestes vitticollis*	Kelaart, Prod. Faun. Zeyl. p. 42.
1888.	*Herpestes vitticollis*	Blanford, Mammalia, No. 64.

Popular names. Badger Mongoose ; Sinhalese, Gal-mugatiya or Locu-mugatiya ; Tamil, Malam-kiri.

Distribution. Type locality, Travancore, South India ; found in the Nilgiris, and in the hills of Coorg and Dharwar in the Indian Peninsular ; locally distributed, in Ceylon, in the Central Hill Zone, and near the sea coast in the Uva and Eastern Provinces (Low-country Dry Zone).

Section CYNOIDEA

Family **Canidae**

Genus **CANIS**

(No. 58). Canis lanka

The Ceylon Jackal

1852.	*Canis aureus*	Kelaart, Prod. Faun. Zeyl. p. 35.
1888.	*Canis aureus*	Blanford, Mammalia, No. 69.
1916.	*Canis lanka*	Wroughton, J.B.N.H.S. Vol. XXIV. p. 652.

Popular names. "Jack" or Jackal; Sinhalese, Nariya or (rarely) Hiwala; Tamil, Narie.

Distribution. Type locality, Mankeni (E.P.), Ceylon; species peculiar to Ceylon: fairly common, locally, in most parts of the Island; generally speaking, it is more common in the Low-country than in the hills

Section ARCTOIDEA

Family **Mustelidae**

Sub-family **Lutrinae**

(No. 59). Lutra lutra ceylonica

The Ceylon Otter

1852.	*Lutra nair*	Kelaart, Prod. Faun. Zeyl p. 35.
1888.	*Lutra vulgaris*	Blanford, Mammalia, No. 92.
1920.	*Lutra lutra ceylonica*	?

Popular names. The Otter; Sinhalese, Diya balla or Mudiya-balla; Tamil, Nair-nai.

Distribution. Type locality, (?) ; sub-species peculiar to Ceylon; common in the neighbourhood of rivers, streams, lakes and tanks throughout the whole Island, but rarely seen.

Family **Ursidae**

Genus **MELURSUS**

(No. 60). Melursus ursinus

The Sloth Bear

1791.	*Bradypus ursinus*	Shaw, Naturalists's Miscellany ii, pl. 58.
1852.	*Prochilus labiatus*	Kelaart, Prod. Faun. Zeyl. p. 34.
1888.	*Melursus ursinus*	Blanford, Mammalia, No. 100.

Popular names. Bear ; Sinhalese, Walaha (he–bear) or Waelahinna (she–bear) ; Tamil, Karradee.

Distribution. Type locality, " interior parts of Bengal " ; common in the forests over the greater part of the Indian Peninsular, from the extreme sonth to the foothills of the Himalayas ; plentiful in, but confined to, the jungles of the Low–country Dry Zone in Ceylon.

Order RODENTIA

Sub–order SIMPLICIDENTATA

Family **Sciuridae**

Sub–Family **Sciurinae**

Genus **PETAURISTA**

(No. 61). Petaurista philippensis lanka

The Large Grey Flying Squirrel

1852.	*Pteromys oral*	Kelaart, Prod. Faun. Zeyl. p. 55.
1891.	*Pteromys oral*	Blanford, Mammalia, No. 227.
1911.	*Petaurista lanka*	Wroughton, J.B.N.H.S. XX. p. 1012.

Popular names. The Large or Grey Flying Squirrel ; Sinhalese, Hambawa or Hangu (Uva Province) ; Tamil, Parravanil.

Distribution. Type locality " Ceylon " ; sub–species peculiar to Ceylon ; fairly common, locally, throughout the Central Hill Zone, and the lower foothills, towards Ratnapura (Sab.) in the south west.

Genus **PTEROMIYS (PETINOMYS)**

(No. 62). Pteromys (Petinomys) layardi

The Small Ceylon Flying Squirrel

1850.	*Sciuropterus layardi*	Kelaart, J.R.A.S. (Ceyl.), II. p. 328.
1852.	*Sciuropterus layardi*	Kelaart, Prod. Faun. Zeyl. p. 57.
1888.	*Sciuropterus fuscocapillus*	Blanford, Mammalia, No. 237 (partim)

Popular names. The Small Flying Squirrel ; Sinhalese, Hambawa ; Tamil, Parravanil.

Distribution. Type locality, " Dimbula " ; species peculiar to Ceylon; rare, found only, very occasionally, in some of the higher jungles at an altitude of about 4,000/5 000 ft. in the Central Hill Zone. It has also been reported from Wellawaya (600 ft.) in the Uva Province.

Genus **RATUFA**

Ratufa macroura

The Long-tailed Giant Squirrel

Three races of the Giant Squirrel are found in different parts of the Island.

(No. 63). Ratufa macroura macroura

Pennant's Long-tailed Giant Squirrel

1769.	*Sciurus macrourus*	Pennant, Ind. Zool. I. Pt. 1.
1852.	*Sciurus tennanti & montanus*	Kelaart, Prod. Faun. Zeyl. p. 30.
1891.	*Sciurus macrourus*	Blanford, Mammalia, No. 241 (partim)

Popular names. The Black Rock Squirrel ; Sinhalese, Dandolena or Kallo dandolena ; Tamil, Mali' anil.

Distribution. Type locality, " Ceylon " ; sub-species peculiar to Ceylon; moderately common in, and confined to, the jungles of the Central Hill Zone, above an altitude of about 3,000 ft.

(No. 64). Ratufa macroura melanochra

The Black and Yellow Giant Squirrel

1915.	*Ratufa macroura melanochra*	Thomas & Wroughton, J.B.N.H.S. XXIV. p. 35.

Popular names. The Black Rock Squirrel ; Sinhalese, Dandolena ; Tamil, Mali' anil.

Distribution. Type locality, Kottawa (S.P.) ; sub-species peculiar to Ceylon ; fairly common in, and confined to, the jungles of the Low-country Wet Zone.

(No. 65). Ratufa macroura dandolena

The Common Ceylon Giant Squirrel

1852.	*Sciurus macrourus*	Kelaart, Prod. Faun. Zeyl. p. 49 (partim)
1891.	*Sciurus macrourus*	Blanford, Mammalia, No. 241. (partim)
1915.	*Ratufa macroura dandolena*	Thomas & Wroughton, J. B. N. H. S. XXIV. p. 35.

Popular names. The Rock Squirrel ; Sinhalese, Dandolena ; Tamil Mali' anil.

Distribution. Type locality, Wellawaya (Uva), Ceylon ; found also in the Madura district of South India ; common throughout the jungles of the Low-country Dry Zone, in Ceylon.

Genus FUNAMBULUS

Funambulus palmarum

The Palm–Squirrel

Four local races of the Palm Squirrel are found in different parts of the Island. The vernacular and popular names are the same in each case.

(No. 66). Funambulus palmarum brodiei

The Northern Ceylon Palm Squirrel

1849.	*Sciurus brodiei*	Blyth, J.A.S.B. XVIII. p. 602.
1852.	*Sciurus brodiei*	Kelaart, Prod. Faun. Zeyl. p. 53.
1891.	*Sciurus palmarum*	Blanford, Mammalia, No. 253 (partim)

Popular names. The Striped Squirrel or "Tree–Rat": Sinhalese, Lena ; Tamil, Anil or Sinna anil.

Distribution. Type locality, Northern Provinces, Ceylon ; sub-species peculiar to Ceylon ; common in, and confined to, the extreme north and north west of the Island, from about Puttalam northwards.

(No. 67). Funambulus palmarum kelaarti

The Lowland Ceylon Palm Squirrel

1850.	*Sciurus kelaarti*	Layard, J.A.S.B. XX. p. 166.
1852.	*Sciurus kelaarti*	Kelaart, Prod. Faun. Zeyl. p. 53.
1891.	*Sciurus palmarum*	Blanford, Mammalia, No. 253 (partim)

Distribution. Type locality, "Southern Provinces," Ceylon ; sub-species peculiar to Ceylon ; common in, and confined to, the Low–country Dry Zone, with the exception of the extreme north (Jaffna) and the north west, where it gives place to the last.

(No. 68). Funambulus palmarum favonicus

The Sub–montane Palm Squirrel

1852.	*Sciurus tristriatus*	Kelaart, Prod. Faun. Zeyl. p 51.
1891.	*Sciurus tristriatus*	Blanford, Mammalia, No. 254.
1915.	*Fanambulus palmarum favonicus*	Thomas & Wroughton, J.B.N.H.S. XXIX. p. 40.
1926.	*Funambulus palmarum matugamensis*	Lindsay, J.B.N.H.S. XXXI. p. 239

Distribution. Type locality, Udugama (S.P.) ; sub-species peculiar to Ceylon ; very common in, and confined to, the Low–country Wet Zone.

(No. 69). Funambulus palmarum olympius

The Highland Ceylon Palm-Squirrel

1852.	*Sciurus tristriatus*	Kelaart, Prod. Faun. Zeyl. p. 51 (partim)
1891.	*Sciurus palmarum*	Blanford, Mammalia, No. 253 (partim)
1915.	*Funambulus palmarum olympius*	Thomas & Wroughton, J.B.N.H.S. XXIV. p. 40.

Distribution. Type locality, Urugalla (C.P.); sub-species peculiar to Ceylon; common in, and confined to, the Central Hill Zone from an altitude of about 1,000 ft. to 4,000 ft.

Funambulus layardi

Two races of this uncommon squirrel are found in different districts in the hills.

(No. 70). Funambulus layardi layardi

Layard's Striped Jungle Squirrel

1849.	*Sciurus layardi*	Blyth. J.A.S.B. XXIII. p. 602.
1852.	*Sciurus layardi*	Kelaart, Prod. Faun. Zeyl. p. 53.
1891.	*Sciurus layardi*	Blanford, Mammalia, No. 255.

Popular names. The Small Black Jungle Squirrel; Sinhalese, Mookula lena; Tamil, Carupu anil.

Distribution. Type locality, Ambegamuwa Hills, Ceylon; sub-species peculiar to Ceylon; uncommon; found in the jungles of the Central Hill Zone at a medium altitude (1,000 3,000 ft.); has been recorded from the Matale Hills and near Kitulgalla (Sab.)

(No. 71). Funambulus layardi signatus

The Flame-striped Jungle Squirrel

1924.	*Funambulus layardi signatus*	Thomas, A. & M.N.H. 9. XIII. p. 239.

Distribution. Type locality, Ratnapura (Sab.); sub-species peculiar to Ceylon; uncommon, found only in the tallest jungles around Ratnapura, Rakwana and Balangoda in the Low-country Wet Zone.

(No. 72). Funambulus sublineatus obscurus

The Ceylon Dusky-striped Jungle Squirrel

1852.	*Sciurus trilineatus*	Kelaart, Prod. Faun. Zeyl. p. 54.
1886.	*Sciurus obscurus*	Pel & Kohl. Verh. Zool. Bot. Ges. Wien. XXXV. p.525.
1891.	*Sciurus sublineatus*	Blanford, Mammalia, No. 256 (partim)
1918.	*Funambulus sublineatus obscurus*	Robinson & Kloss, J.B.N.H.S. XV. p. 24.

Popular names. The Little Jungle Squirrel; Sinhalese, Podi-lena, Tamil, Sinna anil.

Distribution. *Type locality*, "Uplands of Ceylon"; sub-species peculiar to Ceylon; common in most of the jungles of the Central Hill Zone, above an altitude of about 2,500 ft., but also found in the jungles of the interior portion of the Low-country Wet Zone, around Ratnapura and the Udugama Hills.

Family **Muridae**

Sub-Family **Gerbillinae**

Genus **TATERA**

(No. 73). **Tatera ceylonica**

The Ceylon Gerbil or Antelope Rat

1852.	*Gerbillus indicus*	Kelaart, Prod. Faun. Zeyl. p. 69.
1891.	*Gerbillus indicus*	Blanford, Mammalia, No. 264 (partim.)
1917.	*Tatera ceylonica*	Wroughton, J.B.N.H.S. XXV. p. 40.

Popular names. The Sand Rat; Sinhalese, Well-miya; Tamil, Vell' elli (White rat.)

Distribution. *Type locality*, "Ceylon"; species peculiar to Ceylon; common, in suitable country, throughout the Low-country and in the lower hills to an altitude of about 2,500 3,000 ft.

Sub-family **Murinae**

Genus **BANDICOTA**

(No. 74). **Bandicota malabarica**

The Malabar Bandicoot

1801.	*Mus malabaricus*	Shaw, Gen : Zool. II. Pt. I, p. 54.
1852.	*Mus giganteus*	Kelaart, Prod. Faun. Zeyl. p. 58.
1891.	*Nesocia bandicota*	Blanford, Mammalia, No. 296 (partim)

Popular names. The Bandicoot or Bandicoot Rat; Sinhalese, Uru-miya; Tamil, Peritche-' elli.

Distribution. *Type locality*, Malabar Coast, South India; common throughout a great part of the Southern Indian Peninsular; moderately common throughout the Low-country Wet and Central Hill Zones, to the highest altitudes; is probably also found in parts of the Low-country Dry Zone.

Genus GUNOMYS

(No. 75). Gunomys gracilis

The Ceylon Mole Rat

1852.	*Mus dubius* and *Nesokia hardwicki*	Kelaart, Prod. Faun. Zeyl. p. 65.
1891.	*Nesocia bengalensis*	Blanford, Mammalia, No. 295 (partim)
1902.	*Nesokia gracilis*	Nehring, S.B. Geo. nat. Fr. Berl. p. 116.

Popular names. The Paddy–field Rat ; Sinhalese, Wel–miya ; Tamil, Kurumb–'elli or Viel' elli.

Distribution. Type locality, " Ceylon " ; species peculiar to Ceylon · common in the paddy–fields and village gardens of the Low–country Wet Zone and in the hills, to an altitude of 2,500/3,000 ft.

Genus RATTUS

(No. 76). Rattus rattus kandianus

The Common Ceylon House Rat

1852.	*Mus kandianus, ceylonicus, flavescens, tetragonurus, rufo–flavescens, nemoralis, arboreus* and *asiaticus*	Kelaart, Prod. Faun. Zeyl. pp. 61/64.
1891.	*Mus rattus*	Blanford, Mammalia, No. 272 (partim)
1919.	*Rattus rattus kandianus*	Wroughton, J.B.N.H.S. XXVI. p. 794.

Popular names. The Common or Bungalow Rat ; Sinhalese, Miya, (all rats) Gas–miya (tree rat), Gay–miya (house rat) ; Tamil, Yelli (all rats) or Lite' elli (" Line " rat.)

Distribution. Type locality, Nuwara Eliya ; sub–species peculiar to Ceylon ; at the present day, found practically all over the entire Island with the exception, perhaps, of some of the more out of the way Up–conntry jungles. The home of this rat seems to have been the Low–country and lower hills, but it has now spread, as a parasite to mankind almost everywhere.

(No. 77). Rattus rattus kelaarti

The Ceylon Highland Rat or Kelaart's Rat

1915.	*Epimys kelaarti*	Wroughton, J.B.N.H.S. XXIV. p. 48.
1926.	*Rattus rattus kelaarti*	Phillips, C.J. of S. Sec. B. XIII.3. p. 300.

Popular names. The Common Rat ; Sinhalese, Miya (all rats) ; Tamil, Yelli (all rats) or Kart' elli (Jungle rats).

Distribution. Type locality, Pattipola ; sub–species peculiar to Ceylon ; confined to the jungles of the higher hills, of the Central Hill Zone ; is common in the country above 5,000 ft., but in the towns its place is usually taken by the proceeding form.

(No. 78). Rattus blanfordi

The White-tailed Rat

1881.	*Mus blanfordi*	Thomas, A. & M.N.S. (5) XII. p. 24.
1891.	*Mus blanfordi*	Blanford, Mammalia, No. 278.

Popular names. The White-tailed Rat ; Sinhalese, Miya ; Tamil, Vell' elli (White rat).

Distribution. Type locality, Kadapa, Madras ; found in many districts of the Indian Peninsular ; in Ceylon, it is known only from Dammeria Estate, Passara (Uva), where one or two specimens have been taken.

Genus MILLARDIA

(No. 79). Millardia meltada

The Soft-fuwed Field Rat

1837.	*Golunda meltuda*	Gray, Charlesworths. Mag. N. H. I. p.586.
1891.	*Mus mettada*	Blanford, Mammalia, No. 290.

Popular names. Probably the "Field Rat" ; Sinhalese, Miya. Tamil, Yelli or Kart' elli.

Distribution. Type locality, Dharwar, India ; common in many parts of India ; in Ceylon, has been found only in the Southern Province, around Hambantota, in the Low-country Dry Zone.

Genus MUS

(No. 80). Mus dubius

The Common Indian House Mouse

1845.	*Mus dubius*	Hodgson, A. & M.N.H., XV., p. 268.
1852.	*Mus manei* and *musculus*	Kelaart, Prod. Faun. Zeyl. p. 64.
1891	*Mus musculus*	Blanford, Mammalia, No. 282. (partim)

Popular names. The House Mouse ; Sinhalese, Kosatta-miya or Podi-miya ; Tamil, Sund'-elli.

Distribution. Type locality, Nepal, India ; common throughout India and Ceylon ; generally found in association with man.

Genus LEGGADA

(No. 81). Leggada booduga

The Southern Field Mouse

1837.	*Leggada booduga*	Gray, Ch. Mag. N.H.I. p. 586.
1852.	*Mus cervicolor* and *fulvidiventris*	Kelaart, Prod. Faun. Zeyl. p. 64.
1891.	*Mus buduga*	Blanford, Mammalia, No. 287.

Popular names. The Field Mouse ; Sinhalese, Podi Wel-miya ; Tamil, Sund'-elli.

Distribution. Type locality, Dharwar, India ; common over the greater part of India ; common in suitable country over the entire Low-country and lower hills to an altitude of about 4,000 ft.

Genus COELOMYS

(No. 82). Coelomys mayori

Mayor's Coelomys or Spiny Rat

1915.	*Coelomys mayori*	Thomas, J.B.N.H.S. XXIII. p. 416.

Popular names. The Spiny Rat ; Sinhalese, Miya or Kelli-miya ; Tamil, Yelli or Kart' elli.

Distribution. Type locality, Pattipola (C.P.) ; genus and species peculiar to Ceylon ; not uncommon in the jungles and scrub of the highest hills, 6,000 ft. and over, in the Central Hill Zone.

(No. 83). Coelomys bicolor

The Bicoloured Coelomys or Spiny Rat

1915.	*Coelomys bicolor*	Thomas, J.B.N.H.S. XXIV. p. 49.

Popular names. The Spiny Rat ; Sinhalese, Miya or Kelli-miya ; Tamil, Yelli or Kart' elli.

Distribution. Type locality, Kottawa (S.P.), south Ceylon : species peculiar to Ceylon ; not uncommon in the jungles of the Udugama Hills of the Low-conntry Wet Zone, and in the East Matale Hills (Central Hill Zone) to an altitude of about 3,500 ft.

Genus VANDELEURIA

(No. 84). Vandeleuria rubida

The Long-tailed Tree Mouse

1891.	*Vandeleuria oleracea*	Blanford, Mammalia, No. 270 (partim).
1914.	*Vandeleuria rubida*	Thomas, J.B.N.H.S. XXIII. p. 202.

Popular names. The Long-tailed Mouse or the Tree-mouse ; Sinhalese, Podi-gas-miya or Kosatta-miya ; Tamil, Sund' elli.

Distribution. Type locality, Bageswar, Kumaon, North India ; not uncommon in Kumaon ; in Ceylon, this mouse is far from common, but it has been found, occasionally, in several widely scattered places in the hills, to an altitude of 3,500 ft., and also in the Low-country, both in the Wet Zone and in the Dry.

Genus GOLUNDA

(No. 85). Golunda ellioti newera

The Nuwara Eliya Bush Rat

1852.	*Golunda newera*	Kelaart, Prod. Faun. Zeyl. p. 67.
1891.	*Golunda ellioti*	Blanford, Mammalia, No. 299 (patim).
1928.	*Golunda ellioti newera*	Phillips, C.J. of S. Sec.B. XIV. p. 347.

Popular names. The Bush-rat or Field-rat ; Sinhalese, Miya or Coffee-watte miya ; Tamil, Coppie 'elli or Sarak 'elli.

Distribution. Type locality, Nuwara Eliya (C.P.) ; sub-species peculiar to Ceylon ; not uncommon on the patnas, and in the scrub, around Nuwara Eliya and the Horton Plains ; is confined to the higher hills of the Central Hill Zone, above an altitude of about 4,500 ft.

(No. 86). Golunda ellioti coffaea

The Coffee Rat

1852.	*Golunda ellioti* and *coffaeus*	Kelaart, Prod. Faun. Zeyl. p. 67.
1891.	*Golunda ellioti*	Blanford, Mammalia, No. 299 (partim).
1928.	*Golunda ellioti coffaea*	Phillips, C.J. of S. Sec. B. XIV. p. 348.

Popular names. The Coffee-rat ; Sinhalese, Miya or Coffee-watte-miya ; Tamil, Coppie 'elli or Sarak 'elli.

Distribution. Type locality, unknown (probably Kandy, C.P.) ; sub-species peculiar to Ceylon ; not uncommon in grass fields and scrub, and on the boundaries of paddy fields, etc., throughout the Low-country Wet Zone and the lower hills of the Central Hill Zone, to an altitude of about 3,000/4,000 ft. Has also been found around Hambantota in the Low-country Dry Zone.

Family Hystricidae

Genus ACANTHION

(No. 87). Acanthion leucurus leucurus

The Indian Porcupine

1831.	*Hystrix leucurus*	Sykes, P.Z.S. p. 103.
1851.	*Hystrix leucurus*	Kelaart, Prod. Faun. Zeyl. p. 70.
1891.	*Hystrix leucurus*	Blanford, Mammalia, No. 315.

Popular names. The Porcupine ; Sinhalese, Ittawa and Pandura-ittawa ; Tamil, Mallam pundi.

Distribution. Type locality, " Dukhan," India ; common over the greater part of the Indian Peninsular, to as far north as the foot of the

Himalayas ; common throughout the whole of Ceylon, both in the Hills and in the Low-country.

Sub-order DUPLICIDENTATA

Family **Leporidae**

Genus **LEPUS**

(No. 88). Lepus singhala

The Ceylon Black-naped Hare

1852.	*Lepus nigricollis*	Kelaart, Prod. Faun. Zeyl. p. 72.
1891.	*Lepus nigricollis*	Blanford, Mammalia, No. 319 (partim.)
1915.	*Lepus nigricollis singhala*	Wroughton, J.B.N.H.S. XXIV. p. 41.

Popular names. The Hare ; Sinhalese, Hawa ; Tamil, Mossual.

Distribution. *Type locality,* Kumbukkan (Uva) ; species peculiar to Ceylon ; common all over the whole Island.

Order UNGULATA

Sub-order ARTIODACTYLA

Section PECORA

Family **Bovidae**

Sub-family **Bovinae**

Genus **BUBALUS**

(No. 89). Bubalus bubalis bubalis

The Buffalo

1766.	*Bos bubalis*	Linneaus, Syst. Nat. i. p. 99.
1852.	*Bubalus buffelus*	Kelaart, Prod. Faun. Zeyl. p. 87.
1891.	*Bos bubalus*	Blanford, Mammalia, No. 342.

Popular names. The Buffalo : Sinhalese, Wal mee-harrak, Wal-harrak, or Wal meewah (general terms), Kulu-harrak, Kulu-meewah or Kulu mee-harraka (solitary bull), Wal mee-dennah, Kulu mee-dennah, Wal ella-denna, or Kulu ella-denna (cow) : Mee-harrak (tame) ; Tamil, Kadu madu, Kadu errume (general terms), Kalu madu, Kalu errume, Kidda or Kalu-Kidda (solitary bull).

Distribution. Type locality, Rome, Italy (domesticated); the wild buffalo is still found in Central India, and parts of Assam and Kuch-Behar; in Ceylon the truly wild buffalo is now only found in the more remote and wilder parts of the Low-country Dry Zone.

Family **Cervidae**

Sub-family **Cervinae**

Genus **MUNTIACUS**

(No. 90). **Muntiacus malabaricus**

The South Indian Rib-faced Deer or Barking Deer

1852.	*Stylocerus muntjacus*	Kelaart, Prod. Faun Zeyl. p. 85.
1891.	*Cervulus muntjac*	Blanford, Mammalia, No. 362 (partim)
1915.	*Muntiacus malabaricus*	Wroughton, J.B.N.H.S. Vol. XXIV. p. 45

Popular names. The Barking Deer or "Red deer"; Sinhalese, Olu-muwa or Wslli-muwa; Tamil, Mann (all deer), Sembli-mann or (sometimes) Pulatar-mann.

Distribution. Type locality, Nagarhol, Coorg, South India; found, commonly, throughout Coorg, Kanara and the Malabar Coasts of South India; in Ceylon this little deer is common in suitable country throughout the whole Island, to an altitude of about 5,000/6,000 ft. in the Hills.

Genus **AXIS**

(No. 91). **Axis axis ceylonensis**

The Ceylon Spotted Deer

1852.	*Axis maculata*	Kelaart, Prod. Faun. Zeyl. p. 82.
1874.	*Axis maculata ceylonensis*	Fitzinger, Sitz K.A Wiss. Wien. Vol. LXX. p. 269
1891.	*Cervus axis*	Blanford, Mammalia, No. 368 (partim)

Popular names. The Spotted Deer; Sinhalese, Tit-muwa; Tamil, Pullie-mann.

Distribution. Type locality, "Ceylon" sub-species peculiar to Ceylon; common throughout the Low-country Dry Zone and occasionally wandering a few hundred feet into the foothills of the Central Hill Zone.

Genus HYELAPHUS

(No. 92). Hyelaphus porcinus porcinus

The Hog-deer

1777.	*Cervus porcinus*	Zimmermann, Spec. Zool. Geogr. p. 552.
1852.	*Axis orysus*	Kelaart, Prod. Faun. Zeylan, p. 83.
1891.	*Cervus porcinus*	Blanford, Mammalia, No. 369.

Popular names. The Paddy-field deer or "Swamp-deer"; Sinhalese, Gona-muwa or Willa-muwa; Tamil, Mann.

Distribution. Type locality, Indo-gangetic Plain. India; found commonly throughout the Indo-gangetic Plain from Sind and the Punjab to Assam, also in Sylhet and Tennasserim to Burma; in Ceylon, is confined to a narrow strip of country in the Low-country Wet Zone, running along the coast from a few miles north of Kalutara, southwards to near Kottawa in the Galle district.

Genus RUSA

(No. 93). Rusa unicolor unicolor

The Sambhur

1792.	*Cervus axis unicolor*	Kerr.
1852.	*Rusa hippelaphus*	Kelaart, Prod. Faun. Zeyl. p. 83.
1891.	*Cervus unicolor*	Blanford, Mammalia, No. 367.

Popular names. The "Elk" or Sambhur; Sinhalese, Gona; Tamil, Marrei or Komboo-marrei (Stag).

Distribution. Type locality, "Ceylon"; common in suitable jungle country throughout the whole of India and Ceylon.

Section TRAGULINA

Family Tragulidae

Genus MOSCHIOLA

(No. 94). Moschiola meminna

The Indian Chevrotian or Mouse-Deer

1777.	*Moschus meminna*	Erxleben, Syst. Regn. An. p. 322.
1852.	*Meminna indica*	Kelaart, Prod. Faun. Zeyl. p. 81.
1891.	*Tragulus meminna*	Blanford, Mammalia, No. 371.

Popular names. The Mouse-deer; Sinhalese, Meeminna, Capita-meeminna or Walmiya; Tamil, Sarruga-mann or Ukkulam.

Distribution. Type locality, "India" (probably Ceylon); common throughout the jungles of the Indian Peninsular and the whole of Ceylon,

Section SUINA

Family **Suidae**

Sub-family **Suinae**

Genus **SUS**

(No. 95). Sus cristatus cristatus

The Indian Wild Pig

1839.	*Sus cristatus*	Wagner, Münch. gel. Anz. IX. p. 535.
1852.	*Sus indicus*	Kelaart, Prod. Faun. Zeyl. p. 78.
1851.	*Sus zeylonensis*	Blyth, J.A.S.B. XX. p. 173.
1891.	*Sus cristatus*	Blanford, Mammalia, No. 374.

Popular names. Wild Pig or Boar; Sinhalese, Wal-ura; Tamil, Pandi or Kadu-pandi.

Distribution. Type locality, Malabar Coast of India (probably); common, in suitable country, throughout India, Burma, Tenasserim, Siam parts of the Malay Peninsula and the whole of Ceylon.

Sub-order PROBOSCIDAE

Family **Elephantidae**

Genus **ELEPHAS**

(No. 96). Elephas maximus zeylanicus

The Ceylon Elephant

1816.	*Elephas indicus zeylanicus*	Blainville.
1852.	*Elephas indicus*	Kelaart, Prod. Faun. Zeyl. p. 77.
1891.	*Elephas maximus*	Blanford, Mammalia, No. 332 (partim)

Popular names. The Elephant; Sinhalese, Aliya, Athini (cow), Ata (tusker) or hora-aliya (rogue); Tamil, Anei.

Distribution. Type locality, "Ceylon"; sub-species peculiar to Ceylon; formally found in large numbers throughout the jungles of the whole Island, but now-a-days, with the exception of a small herd in the Nuwara Eliya jungles, the Ceylon Elephant is restricted in its range to the jungles of the Low-country.

Order EDENTATA

Sub-order SQUAMATA

Family Manidae

Genus MANIS

(No. 97). Manis crassicaudata

The Indian Pangolin

1803.	*Manis crassicaudata*	Geoffr. St. Hilaire, Cat. Mammalia, p.213
1852.	*Manis crassicaudata*	Kelaart, Prod. Faun. Zeyl. p. 74.
1891.	*Manis pentadactyla*	Blanford, Mammalia, No. 399.

Popular names. The Scaly Anteater or " Armadillo " ; Sinhalese, Kabalaya ; Tamil, Alangu.

Distribution. Type locality, " India " : found locally in most parts of the plains of India, to the foothills of the Himalayas ; in Ceylon is moderately common throughout the Low-country and is found in the lower hills of the Central Hill Zone to about 3,500 ft. altitude.

Order SIRENIA

Family Manatidae

Genus HALICORE

(No. 98). Halicore dugung

1777.	*Trichechus dugung*	Erxleben.
1852.	*Halicore indicus*	Kelaart, Prod. Faun. Zeyl. p.
1888.	*Halicore dugong*	Blanford, Mammalia, No. 398.

Popular names. The Sea-hog or Sea-cow ; Sinhalese, Muda ura; Tamil, Cuddal pandi.

Distribution. Type locality, (?) ; said to be found off the Malabar Coast of India, around the Andaman Islands and in the Mergui Archipelago ; off Ceylon it is found in shallow waters from the Gulf of Calpentyn to Jaffna, on the west coast ; and very occasionally off the north-east coast. The species appears to be in danger of extermination, if not protected.

Order CETACEA

This Order, which is very well represented in the seas round Ceylon, has not yet been satisfactorily worked out.

A New Species of Earth Snake of the Genus Silybura

BY

Lucius Nicholls, M.D., B.A., B.C. (Cantab)

WITH ONE PLATE

Recently when examining the collection of snakes in the Colombo Museum I noticed two specimens of earth snakes of the genus Silybura, these differed markedly from *S. melanogaster* which is the only species of this genus which has been described as occurring in Çeylon.

These specimens were sent by Mr. W. W. A. Phillips from Menia-kanda Group, Gammaduwa, in the East Matale Hills. They were found in garden soil.

Silybura phillipsi sp. nov.

I propose to call this snake *Silybura phillipsi* ; after Mr. W. W. A. Phillips who found the specimens. He expressed the opinion that species which differed from those in the main hill ranges of Ceylon might be expected to be found in the isolated East Matale Hills and this has proved to be correct.

These specimens have the terminal caudal shield of a character peculiar to the genus Silybura. (Plate I, figs. 1 and 2). They measure 21·5 cm. and 22·2 cm. respectively.

Colouration. They are strikingly and beautifully marked with yellow stripes and blotches. The ground colour is a dark bluish grey. There are seven narrow yellow stripes passing along the dorsal surface of the snake. They commence indistinctly just behind the head and end at the caudal shield. These stripes pass through the centres of the scales of the back and in breadth are half the width of the scales. They are separated by six dark slate coloured bands. (Plate I, figs. 3 and 4). There are two series of yellow blotches on each side of this banded area with 34 to 38 blotches in each series. These blotches vary somewhat in size, but most of them are spread over two to three scales longitudinally and vertically. (Plate I, figs. 3 and 4). The darkest scales on the snake are in the two rows bordering each side of the banded area. The scales

of the belly are bordered with yellow. The lips are yellowish. The anal scales and the caudal shield are yellow.

Plate I, fig. 5, shows a piece of skin from *S. melanogaster* for purposes of comparison with the new species. The former species is variable in colour ranging from dark purplish brown to light slate colour, and there are irregular powderings of yellow along the sides.

Lepidosis. The rostral is keeled and touches six shields (2 supralabials, 2 nasals and 2 prefrontals). The rostral is as long as the frontal and 2/5 the length of the shielded part of the head. The nasals are separated from each other by the rostral. The frontal shield is as broad as it is long, and of the same length as the parietal. The supralabials are four in number on each side. The ventrals in the two specimens number 200 and 201 respectively.[1] The sub-caudals number 9 in both specimens. The costals are in 19 rows two head lengths behind the head and in 17 rows two head lengths anterior to the vent, but for the greater part of the body they appear to number 18 (Plate I, fig. 4).

Identification from described species. Twenty-two species of the genus Silybura have been described from India and Burma, including *S. melanogaster* of Ceylon. In eighteen of these the costal rows number 17 or 19 two head lengths behind the head and 17 two head lengths anterior to the vent. But the rostral shield comes in contact with six other shields only in two of these—namely *S. melanogaster* and *S. pulneyensis* (of Travancore). This new species differs markedly from these in its colouration, and also in its scale and shield characters. The following table is a comparison of these characters for the three species. The new species is easily distinguished from the other two by the length of the rostral, the breadth of the frontal and the number of the ventral scales.

	S. melanogaster.	*S. pulneyensis.*	*S. phillipsi.*
Ventrals	141–175	161–180	200–226[1]
Sub-caudals	6–10	6–10	9
Length of rostral to distance from frontal	2/3–3/1	2/1	4/1
Length of rostral to length of frontal	rostral shorter	2/3-3/4	equal
Length of rostral to shielded part of the head	1/3–2/5	2/7–1/3	2/5
Length of frontal to breadth of frontal	longer	longer	equal
Length of frontal to shielded part of the head	½–2/5	less than ½	2/5

1. Since this went to press I have received other specimens, of which the maximum number of ventrals was 226

Type. The type is 222 mm. long. There are 201 ventrals, otherwise the lepidosis agrees with the description given above. The type locality is Meniakanda Group, East Matale Hills. The type specimen will be deposited in the British Museum.

EXPLANATION OF PLATE XXXII

Fig. 1.—*S. phillipsi.* Caudal shield from above. × 5

Fig. 2.—*S. phillipsi.* Caudal shield from the side. × 5

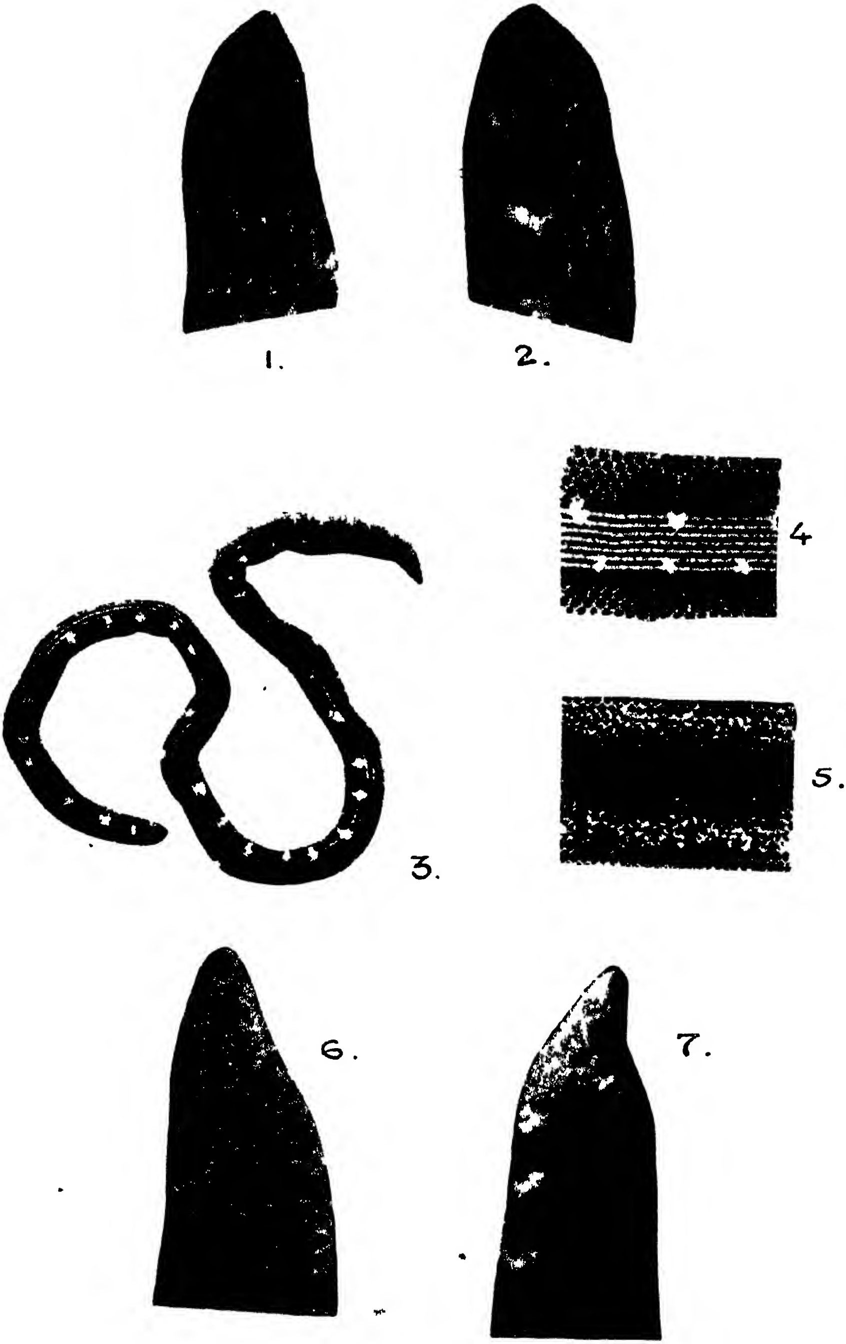
Fig. 3.—*S. phillipsi.* A tual size.

Fig. 4.—Skin of *S. phillipsi.*

Fig. 5.—Skin of *S. melanogaster.*

Fig. 6.—Head of *S. melanogaster* (enlarged). × 5

Fig. 7.—Head of *S. phillipsi* (enlarged). × 5



Silybura phillipsi

A Gecko hitherto unrecorded from Ceylon

BY

P. E. P. Deraniyagala, M. A. (Cantab), A. M. (Harvard)

WITH ONE PLATE

Lepidodactylus lugubris (Dum. & Bibr.)

This gecko was first described in 1836 by Dumeril and Bibron under the name of *Platydactylus lugubris* and was discovered in Ceylon for the first time in 1926 in a Colombo house.

The colouration is different from that given by Boulenger, but its lepidosis and proportions are similar.

The animal is rather sluggish as compared to other geckoes and its note is a series of often repeated subdued "ticks" which are very different from the six or ten loud "ticks" of others. Digits dilated, inner one clawless.

Head longer than broad, snout acute and longer than distance from eye to ear or about twice diameter of orbit. Forehead concave. Gape reaches posterior margin of eye. Pupil vertical, eye contained 1·9–2 in snout. Ear opening small, round, much larger than belly scales. Body elongate with short limbs which do not meet when adpressed. Head and neck contained in body 1·5 times. Tail long, flat, sharp edged and equals 2·75 head and neck. Three females were examined, of which the largest measured : Head and neck 11 mm., trunk 18 mm., tail 31 mm., axilla to groin 13 mm., forelimb (to wrist) 5 mm., hind limb (to heel) 8 mm.

Lepidosis. Rostral quadrangular, broad, its width about 2·5 times its depth. Nostril touches rostral, first labial and three small shields, Five small internasal shields touch upper edge of rostral, followed by granules of head which are larger on snout. Plate XXIII, fig. 3.

Eleven or twelve supralabials and nine or ten infralabials. Mental polygonal, much smaller than rostral, about equal to infralabials, and bordered posteriorly by four transverse rows of small chin shields, (Figure 2).

Throat covered with minute granules which enlarge into, imbricate scales on chest and belly. Four rows of enlarged precloacal scales which equal those on calf of hind leg. Ventral surface of tail has larger scales which are about twice as largc as belly scales and equal to the dorsal scales on tail. Head and body covered with granules dorsally. No enlarged tubercles.

Legs.

Arm. Inner toe has 9 lamellae, of which 4 are bifid—no claw; fourth toe has 15 lamellae,of which five are bifid—claw present;

Leg. Inner toe has 10 lamellae, of which 4 are bifid—no claw; fourth toe has 12 lamellae, of which 4 or 5 are bifid—claw present.

In female an enlarged row of 15 scales runs along the posterior ventral edge of thigh. Behind this row are fine granules. In male according to de Rooij and Boulenger there are altogether 25–31 femoral pores in a long angular series.

Colours (in life). Dorsally the ground colour is cinnamon brown, merging into reddish brown on tail. Labials have dark marginal marks, while a dark line runs from tip of snout to axilla. Three or four short brown lines over each eye, two transverse bars on base of snout. About eight transverse, uniform, undulating brown lines on body and eleven similar but wider bands on tail which give dorsal aspect a ladder-like pattern. These marks have darker W-shaped intensifications which open anteriorly. Limbs and sides possess brown reticulation. Ventrally the body colour is dirty yellow merging into orange on tail. There are one to three stellate black and brown blotches on many scales. These blotches are intenser on tail.

(In alcohol). Dorsally pale brown with a double row of black spots, brown line from snout to axilla. Reticulation on sides and limbs. Ventrally white with small pale brown blotches.

Distribution. Colombo.

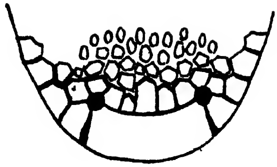
Ceylon, India, Burma, Malay Peninsula and Archipelago, Nicobars, Andamans,Bismarck Archipelago, Solomon Islands, Banks, New Hebrides, Sandwhich Islands, Polynesia, Fiji.

EXPLANATION OF PLATE XXXIII

Fig. 1—*Lepidodactylus lugubris* (Dum. & Bibr.) ×2.

Fig. 2— Do. chin.

Fig. 3— Do. snout.



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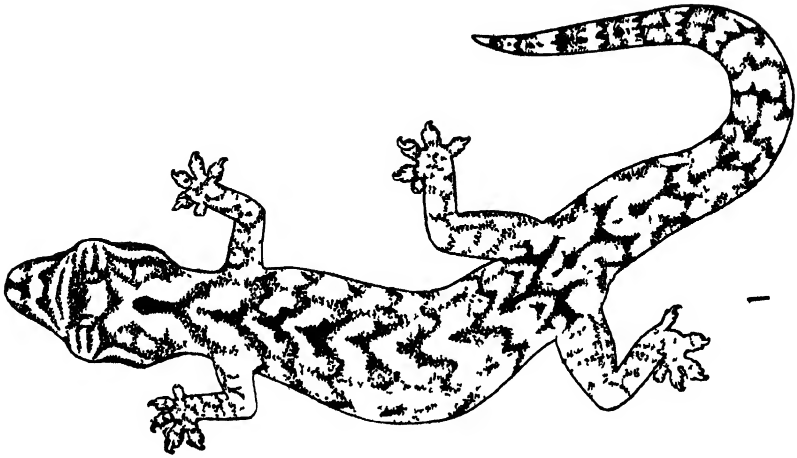

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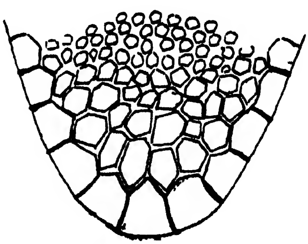

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Lepidodactylus lugubris (Dum. et Bibr.)

P. E. P Deraniyagala del

Hydra zeylanica nov. sp.

BY

D. R. R. Burt, B.Sc., F.L.S.

Lecturer in Zoology, Ceylon University College

WITH ONE PLATE

The following is a preliminary account and description of a new species of Hydra found recently in Ceylon. Hitherto no Ceylon species of Hydra has been described although one has been reported as occurring in the freshwaters of Colombo, including the lake (Willey), and at Peradeniya (Green). (Spolia Zeylanica, vol. iv, p. 18.). Willey thought it likely that this species would prove the same as the common Hydra of Bengal.

A few specimens of a very small Hydra were discovered in August 1928, in a tube of water taken from the stream in Manning Town that flows near the Government Dairy. The water had been collected for Protozoa, but as the tube in question was not rich in the forms required it had been allowed to stand, and the Hydrae were not observed in it until ten days after the water had been collected. There were four specimens, one of which was much smaller than the others and was evidently a newly formed individual just separated from the parent. This small individual when fully extended measured 1·5 mm. from foot to hypostome, while the others were about 3·5 mm. in length. Other individuals have since been obtained from the same stream in different localities, and all the specimens so far observed are referable to the same species being constant as regards the diagnostic characters.

The Hydrae are small in size, measuring from 1·5 mm. to 5. mm. in length from foot to hypostome when fully extended; 1·5 mm. is the measure of a newly separated individual, and 4. mm. is the length of an average specimen. The colour and shape of the body vary within certain limits. An individual which is budding exhibits an approach to the form of *Pelmatohydra,* the oral moiety being thicker and light brown in colour, while the aboral region is stalk-like and clear. The body of an individual which is not bearing buds is uniform in thickness through-

out its length, but the colour may vary. Some individuals are clear, pellucid, and almost transparent, as were the first individuals to be found, while others are light brown in colour and clear only towards the aboral end. This difference in colour appears to be correlated with food supply, for on starving an individual becomes clear and colourless. There are typically four hollow tentacles which may be extended more than twice the length of the body. In eighteen individuals examined only one had more than four tentacles, which Hydra, a five-tentacled creature, arose as the bud of a four-tentacled parent. The tentacles arise in opposite pairs on the bud.

The stinging cells are numerous on the tentacles but appear to be absent from the column. The nematocysts are small and for the most part oval in shape. They measure ·009 mm. long by ·006 mm. broad (unexploded). A few round forms have a diameter of about ·006 mm.

Propagation is in the usual manner, sexually and by buds. The budding region is midway between the foot and the hypostome, that is, towards the aboral end of the thicker region of the body. The buds arise alternately, first on one side and then on the other side of the body, and as they develop they migrate towards the aboral region finally separating about half-way between the bud-forming zone and the foot. There may be more than one bud present at one time but the buds appear not to arise synchronously.

So far only one individual with developed gonads has been obtained. This animal was killed and fixed with a hot saturated solution of corrosive sublimate in alcohol. It was sectioned and the sections were subsequently stained with iron-alum haematoxylin. There were three swellings just proximal to the tentacles, and on account of this position they were considered to be testes. Each gland is a mass of small dividing cells which exhibit almost every stage of karyokinetic division but which are not yet differentiated. The gland has the appearance of a developing testis, but here and there in the mass are cells with nuclei larger than the rest with groups of the smaller cells surrounding them. On this account it is possible that the gonad is an undifferentiated ovary, for in the first stages of development both glands are similar, but, on the other hand, these three glands are situated in the normal position of the testes in other species.

I have observed that the common European species *Pelmatohydra oligactis* Pallas (*Hydra fusca* Linn.) and *Hydra viridis* live in water of different hydrogen ion concentrations, the latter species being found in more acid water, and it is common knowledge that these species are sensitive to sudden changes in the nature of the water in which they live. For instance, neither of these two species will live if transferred from

their natural habitat to tap water. This has been observed also in the case of the Ceylon species, and it is noteworthy that it lives in slightly acid water with a pH of 6·6.

The habitat is the stream in Manning Town, and in the same locality the marshy pools which are confluent with this stream. It is found in association with the pond lily *Nymphaea lotus* v. *pubescens*, and *Utricularia* sp., attached to the underside of the leaves of the former and to the dead and living fronds of the latter. The water is rich in small Crustacea such as *Cyclops*, *Cypris* and *Daphnia*, in mayfly and dragonfly larvae, aquatic bugs and mites, and colonial rotifers.

Without a knowledge of the complete life-history it is difficult to suggest the probable affinities of *Hydra zeylanica*, but it appears to approach *Pelmatohydra oligactis* Pallas, being distinguished from it by the small size, the number of tentacles, and the fact that the stalked form is not permanent. There is, too, a certain resemblance between the summer phase of the common species of Bengal—*Hydra vulgaris* Pallas, phase *orientalis* Annandale—and the Ceylon species. The former occurs in two distinct forms or phases in Bengal . a winter phase which is dark in colour and a summer phase which is light.—(Fauna of British India, Freshwater Sponges, Hydroids and Polyzoa—Annandale). In the more uniformly tropical regions of India the summer phase alone is found. It is this variety which resembles the Ceylon species, particularly as regards colour and the small number of tentacles (4-6). *Hydra zeylanica* is distinguished, however. by its smaller size, by the mode of origin of the buds and of the tentacles, and by the shape and size of the nematocysts.

Briefly this species may be diagnosed as follows :—

Hydra zeylanica

Size :	Length of adult from foot to hypostome when fully extended 1·5 mm. to 5 mm.
Tentacles :	Typically four in number arising in opposite pairs. Length when fully extended more than twice the length of the column.
Nematocysts :	Small, and for the most part oval—·009 mm. × ·006 mm. unexploded.
Colour :	Transparent to light brown.
Shape :	Normally uniform in diameter throughout the length of the body but stalked when budding.

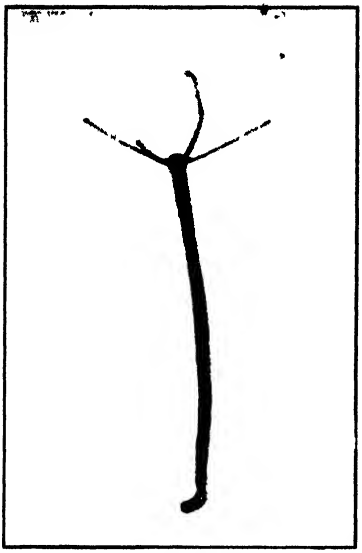
Type Locality : Manning Town, Colombo.

The Type Specimen will be lodged in the British Museum.

I have to thank Professor W. N. Rae for carrying out the determination of the hydrogen ion concentration ; the method he used was Gillespie's indicator method. I have also to acknowledge my indebtedness to Mr. K. M. Michael, Laboratory Assistant in Zoology for his assistance in procuring specimens. It is proposed to work out the life-history of this Hydra in detail at University College.

EXPLANATION OF PLATE XXXIV

1. Photograph of living individual with tentacles retracted. ($\times$ 15)
2. Photograph of individual killed in corrosive sublimate and cleared in Cedarwood Oil. Two of the tentacles are broken off, and the three gonads are conspicuous swellings immediately proximal to this region. ($\times$ 32)
3. Photograph of black and white drawing of Hydra with one developing bud and extended tentacles. It is stalked in appearance. ($\times$6).
4. Photograph of longitudinal section through Hydra in Fig. 2. ($\times$ 125).



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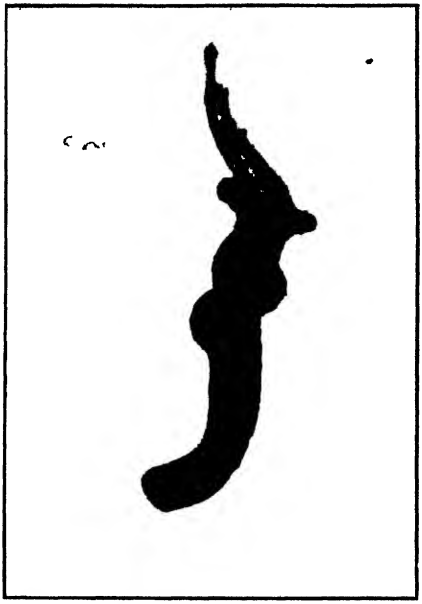

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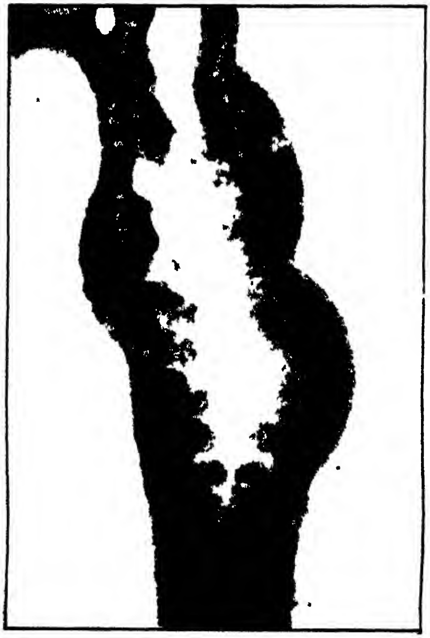


Hydra zeylanica n. sp.

A Note on the Snake-eating propensities of Bungarus ceylonicus, The Ceylon Krait or Karawala

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

A few days ago an interesting example, illustrating the snake-eating habits of *Bungarus ceylonicus*, was sent to me from Pattiagama Estate, Deltota, near Kandy.

The Krait, a very fine specimen, was killed on the verandah of the bungalow, soon after dawn, when the servants were opening the doors. At the time it was killed it was noticed that something,—thought at first to be the snake's tongue,—was protruding from its mouth ; later this was found to be the tail of another snake that it had swallowed.

On cutting open the Krait the second snake was discovered and both snakes were sent down to me for identification.

The snake that had been victimised was a well-grown example of the Ceylon (Gunther's) Cat snake—*Dipsadomorphus ceylonensis*—a common, harmless snake that is often found among the tea bushes on most Up-country tea estates.

The snake-eating propensities of the Krait are well-known, but it usually victimises snakes considerably smaller than itself ; in this case, however, the victim is the larger. Nevertheless it had been swallowed whole, with the exception of a small portion of the tail which still remained protruding from the mouth of the Krait.

The measurements and weights of the two snakes were :

	Krait	Cat snake
Length	812 mm. (31 inches)	861 mm. (33 inches)
Weight	2½ ounces	2 ounces

The Krait is an almost purely nocturnal snake which often takes up its residence in buildings, old stone walls, etc. In this case, most probably, the Krait was returning to its quarters after a very successful night's hunting, when it was killed.

Two New Rodents from the Highlands of Ceylon

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

While I was visiting and collecting in the highlands of the Uva Province, in November last year (1928), I obtained specimens of two small rodents, hitherto unknown from Ceylon, which appear to be new to science.

Both of these animals were obtained on the edge of the forests bordering the Horton Plains, at an altitude of over 6,000 ft. Although the jungles round Pattipola, on the other side of the Hortons, were worked by Major Mayor in 1914 and sundry small collections have been made since on the plains themselves, I do not think that the southern aspect of these hills had received attention until the time of my visit. With the exception of the two new forms herein described, no other small rodents, other than numerous specimens of Kelaart's Rat (*Rattus r. kellarti*) were taken on this trip. I am informed, however, that other species do exist in these jungles.

Vandeleuria nilagirica nolthenii sub. sp. n.

Size generally larger than in *V. rubida* of the low-country of Ceylon ; hind-foot of the type measuring 21 mm. as against an average of 18 mm. in typical examples of *V. rubida* ; tail very long, 1·45 times the length of the head and body, scaly, with fine down throughout its whole length ; ears moderate, naked, but half hidden by the long fur at the base.

Skull. Considerably larger in all dimensions than in *V. rubida.* Occipito-nasal length 24·3 mm. in the type, as against an average of 21·8 mm. in *V. rubida.*

Fur. Moderately long, dense and very soft ; shorter on the underparts ; feet and toes clothed with very fine down ; minute hairs the full length of the long scaly tail ; whiskers numerous and very long—much longer than in *V. rubida.*

Colour. General colour of the upper parts dark rufescent brown, darker on the dorsal area, but more rufescent along the sides and neck ; all fur dark slate-grey at the base ; face dark brown, rather darker on the muzzle ; underparts hoary grey, each hair being dark grey at the base, with a whitish tip ; chest slightly tinged with reddish fawn ; tail and ears dusky ; feet dusky flesh-coloured, with the fine down whitish ; long whiskers shiny black, shorter ones silvery.

Measurements of the type. Length, head and body 84 mm., tail 123 mm., hind-foot 21 mm., ear 13 mm.

Of another smaller male—length, head and body 80 mm., tail 122, hind-foot 20 mm.. ear 14 mm.

Skull.

	Condylo-basal length	*Occipito-nasal length*	*Greatest zygomatic breadth*	*Least Inter-orbital breadth*	*Cranial width.*	*Length of molar series*
of Type	22·5	24·3	12·	4·	11·5	3·8
of smaller male	21·5	24·	12·	4·	11·7	3·8

Type. Adult male ; now in the British Museum. Caught on 30.11.28, at West Haputale Estate, Ohiya, altitude 6,000 ft., in the jungles of the higher hills of the central mountain cluster in Ceylon. The type has been presented to the British Museum ; a paratype, another male, is in the Colombo Museum.

I have much pleasure in associating with this pretty little animal, the name of Mr. A. C. Tutein–Nolthenius, of West Haputale Estate : it was chiefly owing to this gentleman's enthusiasm and kindness that the animal was discovered.

Type Locality. West Haputale, Ohiya, Uva Province, Ceylon, altitude 6,000 ft. The Estate cf West Haputale adjoins the forest and lies just below the southern edge of the Horton Plains.

Habits, Remarks, etc. The type was caught, together with the second male, in a nest of dead leaves, in a hollow tree, growing not far from the edge of the jungle. At the time they were discovered they were both sleeping—it is to be presumed that it is a nocturnal animal like others of the same genus.

In size and other characteristics this new sub-species would appear to approximate to *V. nilagirica* ; it would appear to be the Ceylonese representative of this highland form of Vandeleuria.

Rattus ohiensis sp. n.

Size moderate, much about the same size as *Rattus r. kandianus* the common Ceylon house rat; face elongated and pointed; tail bi-coloured, considerably longer than the head and body, measuring in the type 187 mm., as against a head and body measurement of 150 mm., scaly, with very minute hairs; hind-feet rather long and narrow, with small claws.

Skull. Long and narrow, teeth lemon-yellow.

Fur. Rather short and somewhat harsh, but not spiny or dense; quite short, but soft on the underparts; whiskers very long and numerous.

Colour. General colour of the upperparts dark greyish black-brown, to rather greyish isabelline along the sides; base of fur dark grey, under parts pure white, the white meeting the greyish isabelline of the sides sharply; tail dusky black on the upper half, pure white on the lower, extreme tip whitish; feet dusky flesh-coloured, with the fine fur or down whitish and the claws pinkish white; ears dusky; whiskers shiny black paling to silvery towards the tips.

Measurements of the Type. Length, head and body 150 mm., tail 187 mm., hind-foot 33 mm., ear 22 mm.

Skull. Condylo-basal length 37 mm., occipito-nasal length 4·02 mm. greatest zygomatic breadth 18 mm., least inter-orbital breadth 6·5 mm., cranial width 10·1 mm., length of molar series 5·3 mm..

Type. Adult male: now in the British Museum. Caught on 1.12.28, at West Haputale Estate, Ohiya, altitude 6,000 ft., in the higher ranges of the central mountain cluster in Ceylon. The type has been presented to the British Museum, through the courtesy of the Director, Colombo Museum.

I had intended to associate with this interesting jungle rat, the name of Mr. Oldfield Thomas, the eminent zoologist and to take the opportunity of gratefully acknowledging his most kind help and encouragement as well as his invaluable services to the zoology of Ceylon; but I find that the name is pre-occupied. I have therefore named the species after the locality in which it was discovered.

Type Locality. West Haputale Estate, Ohiya, Ūva Province, Ceylon, altitude 6,000 ft. The Estate where the type specimen was trapped adjoins the forests that surround, on all sides, the highland plateau known as the Horton Plains.

Habits, Remarks, etc. The single specimen obtained was caught in a rat trap, baited with coconut and set among the undergrowth in a ravine in the jungle. As this was the only specimen caught and as it has not been seen before in the neighbouring jungles, it would seem probably that the species is not at all common.

The jungles that it inhabits are subject to high winds and heavy rain ; they are for the most part cold and damp.

It would appear that this rat is allied to *R. niviventer* (Hodgson)—the white bellied or bicoloured rat of the Himalayas. It is curious to note how forms closely allied to Himalayan species crop up in Ceylon while they appear to be absent from the intervening country.

The types of these two new forms and the typescript of this paper were submitted to Mr. Oldfield Thomas, at the British Museum, for his confirmation. Unfortunately Mr. Oldfield Thomas was not well at the time of their arrival : it has not been possible, therefore, to compare the types with the types of allied forms in that Institution.

(Received for publication 1st March, 1929.)

A Monograph on Cestodes of the Order Trypanorhyncha from Ceylon and India. Part I

BY

T. Southwell, D.Sc., Ph.D., A.R.C.S., F.R.S.E.

Lecturer in Helminthology, School of Tropical Medicine, Liverpool; Late Director of Fisheries to the Governments of Bengal, and Bihar and Orissa; Scientific Advisor and Inspector of Pearl Banks to the Ceylon Company of Pearl Fishers; and Honorary Assistant Zoological Survey of India

The Ceylon Pearl Banks yield a very irregular harvest. Occasionally, the Banks have been fished for a few successive years, but the historical record shews that numerous barren years, frequently extending over long periods, have occurred.

In the year 1900 the Colonial Office decided that a thorough investigation of the conditions existing on the banks should be made, with the object of securing annual fisheries, if possible. The late Professor Sir William Herdman, F.R.S., accompanied by Mr. James Hornell, proceeded to Ceylon in December, 1901, in order to carry out the investigations. As a result of these enquiries, Herdman obtained cestode larvae from the Pearl oyster, and later on Shipley and Hornell described a large number of adult cestodes from various sharks and rays. Our first knowledge of the Tetrarhynchid parasites of Ceylon fishes—both Elasmobranchs and Teleosts, is due to the work done by the above authors. Southwell, during the years 1906 to 1911, made extensive collections (mostly *Tetraphyllidea*) including several new species.

Unfortunately, very few of the Tetrarhynchids obtained were adequately described. This was due to a combination of circumstances such as beset the pioneer in any branch of research. The inspection of the Pearl Banks left the writer little time for research and no literature was available.

When the opportunity for a thorough investigation of these parasites did occur, it was found that, unfortunately, the material collected

by Shipley and Hornell had either been lost or dispersed, at any rate it was not available; other specimens had perished owing to evaporation of the preserving fluid, and many of the rest were not in good condition.

The author is, therefore, well aware of the fact that the account of the anatomy of certain species dealt with is so meagre that it is doubtful whether some of them can be identified with certainty from the descriptions given; it is also true that although the details relating to certain other species are sufficient to enable one to identify them, they cannot be regarded as entirely adequate. Our knowledge of the morphology of the worms within the order cannot, however, be extended until quantities of fresh material have been collected and examined.

Dr. Pearson, Director of the Colombo Museum and Marine Biologist to the Ceylon Government, kindly lent the material which the writer had previously deposited in the Colombo Museum, and he has also collected a quantity of new material, especially cystic forms from Teleosts. Lt.-Colonel R. B. Seymour Sewell, I.M.S., Director of the Zoological Survey of India, has also been good enough to lend the collection of Tetrarhynchids which I had deposited in the Indian Museum.

The object of this monograph, which is based on an examination of the material collected by Dr. Pearson and on a re-examination of the material collected by myself which was still available in Calcutta and Ceylon, is twofold, namely, firstly to bring together all the information at present available regarding the Cestodes of the Order *Trypanorhyncha* (Tetrarhynchids) which have hitherto been recorded from Ceylon and India, and secondly, to revise the classification of the Order.

My thanks are due to Dr. Pearson and Lt.-Colonel R. B. Seymour Sewell, I.M.S., for the loan of material, and to Miss E. H. Michie and Miss Florence L. Mandley for many of the illustrations. For assistance in various ways and for the rest of the illustrations I am indebted to David Dagnall, Esq., of the Liverpool School of Tropical Medicine.

Historical

Rudolphi (1819) states that Redi (1684) was the first to describe Tetrarhynchids (larval forms) from *Argentina sphyraena*, but he did not name them; the worms were found in the liver, testes, and intestine.

Gmelin in 1790 gave the name *Echinorhynchus argentinae* to the worms described by Redi.

Rudolphi relates that ;

> 'Redi described 8 worms with the head and half the body white, the rest of the body being yellow ; and again he described more than 50 worms white throughout. The size varies, extending in length beyond the breadth of four fingers across. When contracted they are smaller. They moved like snails and they also carried four little horns on their head, or rather hard (?) and strong hooks, by the help of which they clung to the parts so strongly that he could not tear several away before he had cut away that part they were clasping. All seem to have been free or not enclosed in a sac, for of this sac no mention is made. Yet he states that certain worms lay hidden beneath the outer tunic of the intestine, liver, or ventriculus . . . Some stuck at one time to the first stomach and at another to the tunic of the gut and liver. That the species discovered by Redi (excellent man) is distinct, their different habitats, no less than their size, much greater than the rest, render probable.'

Rudolphi (who objected to naming parasites after their host), in 1809, renamed these larvae *Tetrarhynchus elongatus*. The above is the only description Rudolphi gave of the species and they were not figured.

In 1819 Rudolphi merely records the worm again from the same host, but in this case he names it *Tetrarhynchus argentinae*, *i.e.*, he reverts to the specific name given to the worm by Gmelin, thus indicating according to the Rudolphi custom, that the worm was *sub-judice*. In the same year he created the genus *Anthocephalus* for certain larval worms from "*Orthagoriscorum Molarum*" and the type species of his genus he named *A. elongatus*.

It is clear that *T. elongatus* Rud., 1809 (= *T. argentinae* (Gmel., 1790) Rud., 1819 from *Argentina sphyraena*) is quite different from *A. elongatus* Rud., 1819 from *Mola* (*Orthagoriscus*) *mola*.

Diesing (1850) merely records *T. elongatus* Rud. from the "*ventriculo, intestinis cavo abdominis, hepate et testiculis* (Redi)" of *Scopelus humboldtii*.

It is obvious that he refers to the larva named *Echinorhynchus argentinae* by Gmelin (= *T. elongatus* Rud., 1809), who later changed the name to *T. argentinae*. Apparently this is the only reference to this larval form, and it is thus clear that the adult of the worm found originally by Redi and named *Echinorhynchus argentinae* Gmelin, 1790, *Tetrarhynchus elongatus* Rud., 1809, and later *T. argentinae* Rud., 1819, is unknown: and since a few species of larval forms occur in *Argentina sphyraena* it is obvious that the name *T. argentinae* covers all the species : hence the name *T. argentinae* Rud., 1819, represents a composite species.

With reference to *A. elongatus* Rud., 1819, Linton (1897) records and figures larval forms of *Tetrarhynchus elongatus* Wagener from *Mota rotunda*. Two errors occur in Linton's account, *viz.* (1) the larval form *T. elongatus* was described by Rudolphi, in 1809, and not Wagener, and (2) the name of the host is *Mola rotunda*, not *Mota rotunda*.

Pintner (1913) deals at length with *Anthocephalus elongatus* Rud., 1819. He considers this form identical with " *T. megabothrium* Rud. = *Stenobothrium appendiculatum* (Rud., 1809), Dies., 1850, = *T. bicolor* Diesing," (*sic.* Bartels in Nord.). He gives a description of the adult worm, but there is nothing to indicate that this is the adult of the larval form described by Rudolphi.

Goeze (1782) gave the following description of another parasite which he named *Echinorhynchus quadrirostris* (fig. 1) :—

> '*Candidus, cylindricus, cauda rotunda, corpori intubulata proboscide quadruplici retractili perechinata.*'

His figures 3–5 on Plate XIII shew quite clearly that this worm was a larval Tetrarhynchid. The host is *Salmonis solari.*

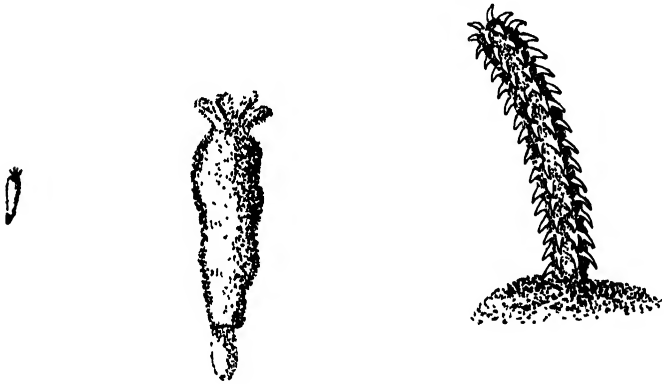


Fig. 1.—*Echinorhynchus quadrirostris.* Magnification unknown (After Goeze)

Zeder (1800) refers to this worm as *Echinorhynchus conicus.*

C. Bosc (1797) defined and gave a figure (fig. 2) of a parasite, which he placed in a new genus named by him *Tentacularia.*

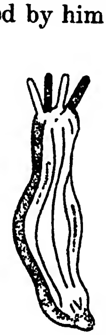


Fig 2.—*Tentacularia coryphaenae.* Magnification unknown (After Bosc).

His account reads :—

'Body enclosed in a sac: apparently no mouth: four retractile tentacles on the head. The species, . . . found on the liver of *Coryphaena hippurus* had a longitudinally striated body. The sac containing it was two lines in length. *Echinorhynchus quadricornis* of Goeze (Linn. Systs. Nat. ed. Gmel. p. 3049, No. 35) should be included in this genus, which, at any rate, appears to be closely related to that of *Echinorhynchus.*'

Apparently Bosc was in error here : he must have meant *E. quadrirostris* Goeze, 1782. There can be no doubt, however, that Bosc was right in including Goeze's species (*i.e. E. quadrirostris*) in his new genus *Tentacularia.* Bosc's parasite was a larval form and no type species was designated.

Treutler in 1795 gave the name *Hamularia lymphatica* to a human parasite which appears to have been a round worm. Zeder, 1803, changed the name of this worm to *Tentacularia subcompressa.*

In 1802, Bosc added a few details relating to his genus *Tentacularia* and gave the species the name *Tentacularia coryphaenae.* He pointed out clearly that the genus *Tentacularia* differed from *Echinorhynchus* in having "its suckers in the form of retractile tentacles."

Rudolphi in 1809 established the genus *Tetrarhynchus.* He divided the parasitic worms into 5 orders, viz.—

Ordinis primi. *Nematoideorum,* including *Filaria, Ascaris,* etc.

Ordinis secundis. *Acanthocephalorum,* comprising two genera only, viz., *Echinorhynchus* and *Tetrarhynchus.*

Ordinis tertii. *Trematodum*—the Trematodes.

Ordinis quarti. *Cestoideorum,* including 6 genera only, viz., *Scolex, Caryophyllaeus, Ligula, Tricuspidaria, Bothriocephalus,* and *Taenia.*

Ordinis quinti. *Cysticorum* with 3 genera only, viz., *Cysticercus, Coenurus* and *Echinococcus.*

The details relating to his second order, viz., *Acanthocephalorum* as given by Rudolphi are as follows :—

'Body rounded, semi-elastic, sac-like, proboscides one or four, with hooks in series, retractile.

Genus (1) *Echinorhynchus* Rudolphi, 1809.
'Body rounded, varied in form. Proboscis evertible; or hooked in series and simple.

Genus (2) *Tetrarhynchus* Rudolphi, 1809.
'Body rounded, varied in form, with four evertible proboscides, hooks in series.'

Rudolphi states that the genus

> '*Tetrarhynchus* differs widely from the genus *Echinorhynchus* in that the former has four proboscides. These latter, one or all, can be everted or retracted in part, or wholly. The internal construction has a peculiarity which distinguishes or separates it from *Echinorhynchus* . . . Goeze, Gmelin, and Zeder wrongly stated that these worms belonged to the genus *Echinorhynchus*. Bosc rightly separated them and gave to them the name *Tentacularia*.'

Rudolphi dealt with four species only of the genus *Tetrarhynchus* and they were all larvae, viz.—

(1). *Tetrarhynchus appendiculatus*

This is the new name he gave to *Echinorhynchus quadrirostris* Goeze, 1782, from "*Salmonis salaris hepate.*" On Plate VII Rudolphi figures this larva (figs. 10 to 12), the figures being copied from Goeze. The adult stage of this worm has never been described.

(2). *Tetrarhynchus papillosus*

This name was given by Rudolphi to the larva called by Bosc *Tentacularia coryphaenae*. Rudolphi likewise figures this larvae on Plate VII, figs. 3–9, and he states that it occurs in "*Coryphaenae Hippuridis Scombri–que Pelamidis.*" In 1819 Rudolphi again changed the name of this larva to *T. macrobothrius* and he recorded it as also occurring in *Testudo mydas* and *Scomber pelamis*.

(3). *Tetrarhynchus elongatus*

Rudolphi gave this name to the larva found by Redi in *Argentina sphyraenae*, which Gmelin had named *Echinorhynchus argentinae*. No figure is given, and, as we have seen above, the identity of this larva is unknown.

(4). *Tetrarhynchus morrhua*

Rudolphi gave this name to larval forms from *Gadus morrhua* which Viborg and Abildgaard had named *Echinorhynchus quadrirostris*.

Rudolphi's descriptions and figures give no clue as to what the adult worms are which are represented by the larval forms *T. appendiculatus* Rud. and *T. papillosus* Rud. We have seen above that the adult form of *T. appendiculatus* has never been described. Von Siebold (1850) and Vaullegeard (1899) state that the adult form of *T. papillosus* Rud. is *Bothriocephalus bicolor* Bartels in Nord, 1832.

Linton (1897) records larval forms of *Tetrarhynchus bicolor* from the following hosts: *Coryphaena hippurus Xiphias gladius*, *Carcharias obscurus*, *Galeocerdo tigrinus*, and the Swordfish (*Pristis* sp. ?). But a perusal of the literature has convinced me that there is very little evidence that such is the case. Further it seems probable that Rudolphi's *T. macrobothrium* (= *T. papillosus*) included more than one species.

Diesing (1850) created the genus *Stenobothrium*, placing in synonymy *Echinorhynchus* Goeze, *Tentacularia* Bosc, and *Tetrarhynchus* Rudolphi. He included two species in this genus, viz. :—

(1) *S. macrobothrium* Diesing,

> Synonyms : *Echinorhynchus coryphaenae* Zeder,
> *Tentacularia coryphaenae* Bosc,
> *Tetrarhynchus papillosus* Rudolphi,
> *Tetrarhynchus macrobothrium* Rudolphi.

from *Coryphaena hippurus*, *C. equisetis*, *Pelamys sarda*, *Halichelis atra*, and

(2) *S. appendiculatum* Diesing,

> Synonyms : *Echinorhynchus quadrirostris* Goeze,
> *Echinorhynchus conicus* Zeder,
> *Tetrarhynchus appendiculatus* Rudolphi.

from the liver of *Salmo salar*.

Vaullegeard (1899) states that the adult form of *T. appendiculatus* is not known.

In 1810 Rudolphi included what are now known to be adult Tetrarhynchids in his genus *Bothriocephalus* (*armati*, *echinobothria*). He described two species, namely, *B. corollatus* (= *Halysis corollata Zeder* 1782 =*Taenia corollata*, Abildgaard, 1790), and *B. paleaceus* (= *Taenia squali Fabricius*, 1794).

In 1811 Bosc erected the genus *Hepatoxylon* for a worm found in the liver of a shark ; this worm had an articulated body, four tentacles, and four suckers " which latter have some analogy with those of the Taenia and of the hydatids."

Cuvier (1817) established the genus *Floriceps* with the following characters :—

> 'With four small proboscides, or tentacles, armed with hooks, by means of which they attach themselves to the viscera of their hosts. There is one which is quite common in Rays, viz., *Bothriocephalus corollatus* Rudolphi, 7 inches in length. Its head is just like a flower.'

Clearly, this genus only contained adult *Tetrarhynchid* worms. In the same publication Cuvier defined the genus *Tetrarhynchus* Rudolphi, 1809 = *Tentacularia* Bosc., 1797, as follows :—

> 'They appear to be only *Floriceps* consisting simply of the head, and two segments, instead of an elongated body and several segments. Very often one is found in the flesh of the tongue of the turbot and several other fishes.

Evidently Cuvier considered that Rudolphi's genus *Tetrarhynchus* contained larval forms, whilst his own genus *Floriceps* contained adult forms.

Rudolphi in 1819 again defined and classified the parasitic worms as follows :—

Order 1. NEMATOIDEA.
„ 2. ACANTHOCEPHALA.
„ 3. TREMATODA.
„ 4. CESTOIDEA.

Genera :—*Caryophyllaeus*,
Scolex,
Gymnorhynchus,
Tetrarhynchus,
Ligula,
Triaenophorus,
Bothriocephalus — *Dibothrius*,
Tetrabothrius,
Onchobothrius,
Rhynchobothrius.

Taenia.

Order 5. CYSTICA.

Genera —*Anthocephalus*,
Cysticercus,
Coenurus,
Echinococcus,

and ENTOZOA DUBIA

Order CESTOIDEA Rudolphi, 1819.

'Body elongated, flattened, soft, either entire or segmented. In a few the head is simply labiate ; in others it is furnished with bothridia, or with two or four suckers. All are hermaphrodite.'

Genus (1) *Gymnorhynchus* Rudolphi, 1819.

'The body is continuously flattened and tapering, very long, *with a sub-globular receptaculum in the neck*. The head bears two bipartite bothridia. Proboscides four, retractile, nude.'

G. reptans Rudolphi = *Scolex gigas* Cuvier.

Genus (2) *Tetrarhynchus* Rudolphi, 1809.

'Body continuously flattened. The head bears two bipartite bothridia emitting four, hooked, retractile proboscides.'

Genus (3) *Bothriocephalus* Rudolphi, 1819.

'Body elongated, flattened, segmentated. Head squarish with two or four opposite bothridia.'

Order CYSTICA Rudolphi, 1819.

'Body flattened and rounded, with posterior extremity ending in a single vesicle with a single entozoa or often with many. Head with two or four bothridia and four suckers with a ring of hooks, or furnished with four hooked proboscides.'

Sexual organs have been found in none so far.

Genus *Anthocephalus* Rudolphi, 1819.

'Exterior vesicle hard and elastic, containing another slighter one in which is a single entozoon, of which the body is elongated, flattened, and ends at the base in a widened caudal vesicle. Head provided with two or four bothridia and four hooked proboscides.'

Clearly this genus contains larval forms only.

Rudolphi, discussing the genus *Tetrarhynchus*, wrote :—

'Redi, who first described *Tetrarhynchus*, found it in *Argentina sphyraena*. It happened then that Goeze examined another species from *Salmonis solare* . . . he was not able to determine its nature and added it to *Echynorhynchus* ; Gmelin in his confusion, following Redi, also placed it in *Echynorhynchus*. Then a third species was found by Bosc in *Coryphaena hippurus* and taken, according to his statement, for a new genus *Tentacularia* and incidentally described. Abildgaard saw a fourth species in *Gadus morrhua* but did not describe it . . . Previously, Gaede . . . brought specimens of the third species found by Fischer in the branchia of *Xiphiac*, and I saw it was to be numbered neither among *Tetrarhynchus*, *Cestoidea*, nor among *Acanthocephales*. Cuvier included *Tetrarhynchus* under *Taenoidea* owing to its nature . . . In Italy I examined many living specimens.

'Several, if not all, of those called by me *Anthocephala*, belong to *Cystica*, since it was advisable to separate from *Tetrarhyncha* those without a caudal cyst. *Bothriocephala* are similarly given as being akin to *Tetrarhyncha*, but they differ greatly in having a segmented body.'

It is evident that Rudolphi considered his genus *Tetrarhynchus* to contain worms without a segmented body, *i.e.* larval forms.

Dealing with the genus *Bothriocephalus*, Rudolphi states that

'several genera can easily be confused with, or included in, my *Bothriocephalus*, viz., *Dibothrius* 1–15 sp. *Tetrabothrius* (which can again be easily divided into 16–19 species) *Onchobothrius* sp. 20–22. *Rhynchobothrius* species 23–24.'

The latter is the first mention of the genus *Rhynchobothrius*, and Rudolphi does not define the characters of the genus.

'*Bothriocephalus* in having two bothridia lateral or marginal can easily be distinguished from *Taenia* which has four mouths. I have seen other species of *Bothriocephalus* with four proboscides but these are less deep than those of *Taenia*. One species (*B. annulatus*, n. 18, inhabiting *Torpedo*) the position of which is full of doubt.'

de Blainville (1828) divided his Order III. (BOTHRIOCEPHALA as follows :—

Family I. POLYRHYNQUES.

(a) *Dirhynques.* — *Dibothriorhynques.*

(b) *Tetrarhynques.* — *Gymnorhynque, Tentaculaire, Tetrarhynque.* — *Floriceps, Rhynchobothrie.*

Family II. MONORHYNQUES.

(a) *Téniosomes.* — *Triaenophore, Onchobothrie, Halysis.* — *Ténia, Fimbriaire.*

(b) *Hydatisomes.* — *Hydatigère, Cysticerque.* — *Coenure, Echinocoque.*

Family III. ANORHYNQUES. — *Massette, Alyselminthe, Tetrabothrie.* — *Bothridie, Bothriocephale, Ligule.*

Dujardin in 1845 classified the worms as follows :—

Class 1. NEMATOIDES.
Class 2. ACANTHOTHEQUES (*Acanthotheca* Diesing). Pentastomes
Class 3. TREMATODES.
Class 4. ACANTHOCEPHALES (*Echinorhryngus* Müller).
Class 5. CESTOIDES.

Order 1. RHYNCHOBOTHRIENS.
Genera :—*Rhynchobothrius,*
Anthocephalus,
Tetrarhynchus,
Gymnorhynchus,
Dibothriocephalus.

Order 2. CESTOIDES VRAIS ou TÉNIOIDES.
Genera :—*Taenia,*
Bothriocephalus.

Order 3. SCOLECINES
Genera :—*Caryophyllaeus.*
Proglottis,
Scolex,
Gryporhynchus,
Dithyridia.

Order 4. CYSTIQUES.
Genera :—*Cysticercus*,
Coenurus,
Echinococcus,

and Helminths of uncertain position.

Order 1. RHYNCHOBOTHRIENS.

'Cestodes furnished with four (or two ?) retractile proboscides covered with hooks.'

Genus (1). *Rhynchobothrius.*

'Very long worms, tape-like, formed of numerous segments and terminated anteriorly by a neck and a head. Head covered with two large bifid contractile lobes ; between these two lobes arise from each side two retractile proboscides covered with unequal hooks ; eggs elliptical with simple envelopes.

'*Rhynchobothrius* has been included by Rudolphi amongst his *Bothriocephalus* of which they form a special section called by him first *Echinobothria*, then *Rhynchobothria*. They are so like *Anthocephala* in their anterior part that one can think that these two genera represent two degrees of development of the same type. The three known species live in the gut of sea fishes and particularly *Chondropterygiens*.'

Genus (2). *Anthocephalus* Rud. = *Floriceps* Cuvier.

'Worms with a long cylindrical body, distended on both sides and folded back in two at the extremity, which develops in a cartilagenous oblong, club-shaped cyst. The head of the *Anthocephalus* is globular, quadrangular, covered with two large folded back lobes (bothria) and bearing four retractile proboscides covered with hooks which emerge from the commisure of the lobes. The posterior part contains four retractile, muscular fascia which communicate with each of the proboscides by a tube, or sinuous canal, often almost spiral.'

'*Anthocephalus* resembles very much the anterior part of *R. corollatus*; the two genera represent two different stages of the same worm. The mode of development of *Anthocephala* is one of the most curious facts of Helminthology.

'They are all helminths in which the adults are not known with certainty.'

A macrourus, found by Olfers in cysts in the liver of a *Sparus* in Brazil was described by Rudolphi as having a long thin neck, (13 mm.) followed by an oval receptaculum 6·7 mm. in length, which is terminated by a caudal cylindrical vesicle, which is about 54 mm. long. Creplin remarks with reason that Bremser represented under this name, not *A. macrourus* as it is described, but *G. reptans*. This is quite true, as Rudolphi points out that in his genus *Gymnorhynchus* there is a vesicle in the neck, whereas in *Anthocephalus* the vesicle is posterior.'

Genus 3. *Tetrarhynchus* Rudolphi.

'Worms with a short body shaped like a cylindrical sac or slightly distended to a club-like form, covered anteriorly by two lobes which are folded back ; four retractile proboscides present covered with hooks of equal size. Worms of this genus were first included in *Echinorhynchus*, because of their somewhat similar proboscides ; Bosc called a species *Tentacularia* which he had found and this generic name was later adopted by Blainville ; Rudolphi gave them a more appropriate place in his order of Cestodes, but one must still group them with *Anthocephalus* and *Rhynchobothrius*, of which they are perhaps a young stage as Bremser thinks ; all found in flesh or living in tissues of fishes.'

Genus 4. *Gymnorhynchus* Rudolphi.

'Worm flattened, very long and narrow, unsegmented; head distinct with two large bilobate depressions (dimples) or divided by a median rib, and four very long proboscides, nude at the base and armed with hooks in the whole retractile portion, so that they appear to be short and completely unarmed when they are retracted to the basal part. Neck thin, long, emerging from a long ovoid receptaculum which contains the retractile muscles of the proboscides; no genitalia. The only worm in this genus was discovered in the flesh of *Brama raii* by Cuvier, who called it *Scolex gigas*. Rudolphi, who only saw the unarmed portion of the proboscides, made a genus *Gymnorhynchus* characterised by nude proboscides, but Bremser shewed that the proboscides are armed over the major part of their length.'

G. reptans (= *Scolex gigas* Cuvier = *G. reptans* Bremser = *G. reptans* Creplin). One metre in length, 2·5 to 4·5 mm. in width.

Receptaculum of proboscides muscles ovoid, 8–13 mm. in length, 6·9 mm. in width; neck 2·25 mm. in width; found in *Brama raii*.

Genus 5. *Dibothriorhynchus* Blainville.

'Body rather short, sac-shaped, flattened, non-segmented, terminated posteriorly by a small evertible tubercle; head cuneiform (wedge or arrow-shaped) provided with a lateral depression on its two wide faces and with a globular proboscis. This genus was established by Blainville on a single specimen found in the gut of *Lepidopus argyreus* Cuvier.'

Van Beneden's classification of the Cestoda (1849) is as follows:—

Acotyles or *Vers Cestoides*	*Tetraphylles*	*Phyllobothriens*	*Echénéibothrium*, *Phyllobothrium*, *Anthobothrium*
		Phyllacanthiens	*Acanthobothrium*, *Onchobothrium*, *Calliobothrium*
		Phyllorhynchiens	*Tétrarhynque*
	Diphylles	—	*Échinobothrium*
	Pseudophylles	—	*Bothriocephalus*, *Tricuspidaria*
	Aphylles ou *Téniens*	—	*Ténia*

His description of the *Phyllorhynchiens* and of the genus *Tétrarhynque* reads:

'These animals are distinguished first by the four bothridia, common to the whole section, and to which correspond four retractile proboscides covered with hooks disposed spirally and situated in a membranous sheath. There is always one part quite distinct, known as the neck; it is the inferior part of the scolex. Longitudinal canals traverse the whole length of the scolex and strobila and arise posteriorly in the interior of the bothridia . . .

'*Anthocephalum* Rudolphi is a synonym of *Floriceps* Cuvier . . . *Tetrarhynchs* are only *Anthocephala* which are older . . . The genus *Gymnorhynchus* was established owing to an error of observation; the proboscides are not hookless as was supposed: and the body presents no characteristic. Blainville was right in uniting in his "Atlas" *Anthocephalus macrourus* and *Gymnorhynchus reptans* under the same name. Only one species of *Gymnorhynchus* was known and this was figured by Bremser. It has a vesicular swelling anteriorly and the body bears no traces of segmentation. To this species, viz., *G. reptans* or *Scolex gigas* Cuvier, Goodsir has lately added a second species, viz., *G. horridus*. The name *Tentacularia* has also been given to another worm of this family, but this generic distinction seems to me to have no more value than the preceding genera . . . We still have two names, viz., *Tetrarhynchus* and *Rhynchobothrium*; the first was given long ago to worms of this family which are deprived of their vesicle and which live freely; whilst the second was proposed lately only for those worms which have a strobilus. Which must be adopted? I think the older name, viz., *Tetrarhynchus*. If one decided according to priority one would have to adopt the name *Floriceps* Cuvier or *Anthocephalum* Rud.'

van Beneden, defining the genus *Tetrarhynchus*, wrote:—

'As only one genus of this family is known, it is useless to enumerate its characters.'

Diesing in 1850 classified the worms as follows :—

Order IV CEPHALOCOTYLEA Diesing.

Sub-Order 1. Aprocta with two, four or eight acetabula or bothria

Tribe I. CYSTICA Rud.

Genera :—*Cysticercus* Rud.
Coenurus Rud.
Echinococcus Rud.
Piestocystis Diesing, 1850.

Tribe II. TAENIODEA Diesing.

Genera :—*Taenia* Linn.
Arhynchotaenia Diesing.
Rhynchotaenia Diesing.
Sciadocephalus Diesing.
Ephedrocephalus Diesing.
Amphoteromorphus Diesing.
Peltidocotyle Diesing.

Tribe III. THECAPHORA

Genera :—*Anthocephalus* Rud.
Acanthorhynchus Diesing.
Pterobothrium Diesing.

Tribe IV. BOTHRIOCEPHALIDEA Diesing.
Sub-tribe I. RHYNCHOBOTHRIA Rud.
Section I. *Dibothria* Dies.
Genera :—*Dibothriorhynchus* Dies.
Tetrarhynchus Rud.
Rhynchobothrium Rud.
Section II. *Tetrabothria* Diesing.
Genera :—*Tetrabothriorhynchus* Dies.
Stenobothrium Dies.
Tetrarhynchobothrium Dies.
Synbothrium Dies.
Sub-tribe II. GYMNOBOTHRIA Rud.
Section I. *Monobothria.*
Genera :—*Caryophyllaeus* Gm.
Bothriomonus Duv.
Section II. *Dibothria* Dies.
Genera :—*Ligula* Bl.
Schistocephalus Crep.
Dibothrium Rud.
Solenophorus Crep.
Section III. *Tetrabothria* Diesing.
Genera :—*Scolex* Müll.
Tetrabothrium Rud.
Zygobothrium Dies.
Section IV. *Octobothria* Dies.
Genus *Octobothrium* Dies.
Sub-tribe III. ONCHOBOTHRIA Rud.
Genera :—*Triaenophorus* Rud.
Onchobothrium Rud.

Diesing's definitions were as follows :—

Order IV. CEPHALOCOTYLEA

Alimentary canal slightly bifurcated or simple. The acetabula or bothridia, 1, 2, 4 or 8 in number are in the head. All are endoparasites. The animal is gregarious or solitary, white or grey, transparent or opaque, blind or very rarely furnished with small eyes, very long, sometimes reaching 40–100 feet in length. The body is soft, parenchymatous, flat, rarely rounded, swelling at the caudal extremity into a vesicle filled with clear liquid or into a receptaculum situated (a) at the extremity of the body, or (b) between the neck and the body, or (c) compressed with neither a vesicle nor a receptaculum. *Head* continuous with or distinct from the neck (the unsegmented part behind the head). *Acetabula* spherical (the suckers of authors) or elongate, mostly narrow (bothridia of authors) inserted in the head. Mouth terminal or subterminal and anterior. Oesophagus short. Intestinal tract slight, mostly bifurcated and without anus, more rarely simple with anus. System

of vessels present. Cerebral ganglion seen in a few. Genital organs—none or both sexes joined in one animal, or rudimentary. Penis (lemniscus of authors) protractile, thread-like; female genital aperture present. Propagation by prolification or eggs. All are endoparasites.

Tribe III. THECAPHORA Diesing (= *Cystica* Rudolphi)

Animal solitary. Body continuously elongated. Receptaculum (vesicle) wide at the base of the body and placed between neck and body. Neck rounded, continuous with the body and with its base, retractile into the receptaculum. Head with two or four bothridia and four terminal proboscides which are armed and retractile. Mouth terminal. Genital organs not seen. Multiplication uncertain. In sea fishes of hot or tropical regions; in various organs often enclosed in a cyst or free, but not found in gut.

Genus *Anthocephalus* Rud. (= *Floriceps* Cuvier).

Body taenia-shaped, continuously flattened, with the neck tubular anteriorly, terminated posteriorly with a large receptaculum at the base. Head has two obliquely opposite bothridia. Proboscides; four terminal opposite, hooked. Mouth terminal in the midst of the proboscides.

Genus *Acanthorhynchus* Diesing.

(= *Scolex* Cuvier -- *Gymnorhynchus* Rud.
- *Anthocephalus* Bremser = *Bothriorhynchus* van Lidth de Jeude).

Body taenia-shaped, continuously flattened, very long. Receptaculum spherical, large, neck separated from the body, long, tubular; head retractile into receptaculum, square at the back, with two opposite bothridia, notched at their posterior margin. Proboscides continuing to the internal upper margin of the bothridia, hooked, base wide, retractile, much longer than the head. Mouth terminal, in the midst of the proboscides. In the flesh of sea fishes.

Genus *Pterobothrium* Diesing.

(-- *Anthocephalus* Rud.)

Body continuously elongated, flattened or rounded. Receptaculum separates the neck from the body. Neck long, tubular, with head retractile into receptaculum. Head square with four terminal bothridia situated in the shape of a cross, joined at the base by a membrane.

Proboscides four, traversing the bothridia in the middle and longitudinally and emerging from the apex; very long and armed spirally. Mouth terminal at the base of the bothridia.

Diesing here divides those forms with a spherical vesicle in the neck, into two genera, one bearing two, and the other four, bothridia.

On the surface of the viscera of sea fishes and liver and swim bladder. Often enclosed in a single cyst.

Species:—*P. macrourum* = *Anthocephalus macrourus* Rud. not Bremser.
P. crassicolle Diesing.
P. heteracanthum Diesing.
P. interruptum. Diesing.

Tribe IV. BOTHRIOCEPHALIDEA Diesing

Animals solitary and androgynous. Body elongated, flattened, taenia-shaped or rounded, continuously or transversely folded into rings. or segmented. Head continuous with the body or separated by a neck ; with a single terminal bothridia or two, four, or eight opposite one another, with either no proboscides or with four retractile armed proboscides. Mouth (in some at least) quite terminal. Oesophagus very short. Alimentary canal bifurcates and runs along the margin of each side of the body ; it is joined to the subcutaneous part of the vessels, and has no anus. Cerebral ganglion not seen. Genital aperture sometimes none, sometimes difficult to see, mostly lateral, more rarely marginal, or marginal and lateral. Penis (lemnisci of authors) unarmed and thread-like. Genital organs, male and female, are in various degrees of evolution, not in the anterior segments, nor in the middle segments, but in the most highly developed. Fertilized eggs cast off immediately with segments.

Found in the intestinal tract of vertebrates and especially of fishes, but not in other viscera. Amongst non-vertebrates it is found only in *Cephalopods* and *Molluscs* as endo-parasites ; either enclosed in a cyst or free.

Sub-tribe I. RHYNCHOBOTHRIA Rudolphi.

Body rounded or flattened, continuous or segmented. Head continuous with the neck ; two or four unarmed bothridia. Proboscides four, armed, retractile. (The internal structure of the neck is analagous in all to the neck of *Thecaphora* (conf. *Anthoceph. giganteum*), the remaining structure is not well-known).

Section *Dibothria*. Two bothridia

Monarthra. Body continuous

Genus *Dibothriorhynchus* Diesing.

(= *Tetrarhynchus* Rudolphi = *Bothriocephalus* Leuckart).

Body continuous, rounded or slightly flattened. Neck tubular, retractile, shorter than the body. Head has two bothridia lateral, converging to apex. Proboscides four, terminal, thread-like, retractile. Mouth terminal (?)

Genus *Tetrarhynchus* Rudolphi.

(= *Hirudo*, La Martinièré = *Hepatoxylon* Bosc.
= *Echinorhynchus*, Abildgaard = *Bothriocephalus* Leuckart = *Dibothriorhynchus* Blainville).

Body continuous, very short, papilliform. Neck long, flattened, continuous. Head large, with two lateral, parallel, bothridia, each one divided into two by a longitudinal septum. Proboscides four, terminal, armed, retractile shorter than the head. Mouth terminal (?). Genital organs, none externally. In the *tunicis ventriculi et ad branchia* of marine fishes, very rarely in intestines.

Genus *Rhynchobothrium* Rudolphi. charact. emend.

(= *Taenia* Fabricius = *Bothriocephalus* (*Rhyncobothrium*) and *Tetrarhynchus* Rudolphi = *Bothriocephalus* van Lidth de Jeude).

Body flattened, taenia-shaped, segmented. Neck tubular. Head continuous with the neck, with two opposite lateral bothridia, parallel, but

converging at the apex. Proboscides four, terminal, thread-like, armed, retractile, longer than the head. Mouth terminal (?). Genitalia external, prominent.

In the intestinal tract of sea fishes, more rarely in other organs.

Section II. *Tetrabothria.* Four bothridia

Monarthra : Body continuous

Genus *Tetrabothriorhynchus* Diesing.

(= *Fasciole* Linné = *Distoma* Zeder = *Scolex*, Rudolphi. = *Tetrarhynchus* Auct. = *Dibothriorhynchus* Chiaje = *Corynesome* Leuckart = *Amphistome* Leblond).

Body very short, flattened, retractile into neck. (A fallacy is that the sucker is retractile). Neck long, tubular, rounded at the base, slightly flattened (when the body is shortened) or slightly cylindrical (when body is stretched). Head continuous with the neck, with four bothridia, placed in pairs, opposite to one another, converging anteriorly, bent to oval-shape, half the length of the neck. Proboscides four, terminal, armed, cylindrical, retractile, short. Mouth terminal (?). Genitalia, none externally.

In various organs of sea fishes either enclosed in a cyst or free; also found in *Cephalopods* and *Molluscs.*

Genus *Stenobothrium* Diesing.

(= *Tentacularia* Bosc = *Echinorhynchus* Goeze = *Tetrarhynchus* Rudolphi).

Body very short, flattened, retractile into neck (a fallacy is that the sucker is retractile) continuous. Neck short, slightly flattened, Head thickened, very long, with four lateral bothridia placed in pairs opposite one another, parallel, rising from the head, almost as long as one another. Proboscides four, terminal, armed, retractile, short, sub-cylindrical. Mouth terminal (?) Genitalia none externally.

In various muscles and *inter tunicas ventriculi* of fishes or tortoises; in the liver, enclosed in a cyst or free.

Genus *Tetrarhynchobothrium* Diesing.

Body slightly flattened, segmented. Neck tubular. Head, with four lateral bothridia, placed in pairs opposite one another; oval, lanceolate, scythe-shaped at the base and converging at the apex. Proboscides four, terminal, thread-like, armed, retractile, longer than the head.

Genital apertures :—Papilliform, scattered, alternating, marginal. Penis retractile. In intestines of sea fishes.

Genus *Synbothrium* Diesing.

Body taenia-shaped, segmented. Neck tubular, rounded at base. Head square, with four terminal free bothridia arranged in the shape of a cross, oval, slightly convex, joined at the base by a membrane. Proboscides four, arising from the apex, each one traversing the middle of a bothridium, armed, long and retractile. Mouth terminal, at the base of the bothridia. Genital apertures (?). In the intestine of tropical sea fishes.

• Similar to *Pterobothrium* in shape of head, from which it differs, however, because *Synbothrium* lacks the receptaculum in the neck and has a segmented body. *S. fragile* Diesing.

Diesing's classification is very involved, but it can be summarized as follows :—

Tribe THECAPHORA

Head with two or four bothridia—All larval Tetrarhynchids with a bladder (*i.e.* they are encysted).

1. *Acanthorhynchus.* Two bothridia; vesicle between neck and body. In flesh of sea fishes.
2. *Pterobothrium,* Four bothridia; vesicle between neck and body. In viscera, etc., of sea fishes.
3. *Anthocephalus.* Two bothridia; vesicle at caudal extremity. In viscera of various fishes.

Tribe BOTHRIOCEPHALIDAE
Sub-tribe (1) *Rhynchobothria.*

With two or four bothridia and without a bladder (that is, they are not encysted). Apparently the sub-tribe contains both larval and adult forms. With the following seven genera :—

(1) *Dibothriorhynchus.* Two bothridia; a larva.
(2) *Tetrarhynchus.* Two bothridia, each divided into two by a septum; a larva.
(3) *Tetrabothriorhynchus.* Four bothridia, ovate, lanceolate; a larva.
(4) *Stenobothrium.* Four bothridia; a larva.
(5) *Rhynchobothrium.* Two bothridia; adult worms.
(6) *Tetrarhynchobothrium.* Four bothridia, lateral; adult worms.
(7) *Synbothrium.* Four terminal bothridia arranged in the shape of a cross; adult worms.

Diesing, in 1855, dealing with the Order *Cephalocotylea.* Section I. *Paramecocotylea,* re-defined his genus *Pterobothrium* Diesing, 1850, as follows :—

Pterobothrium Diesing, 1850.

'Body elongated, continuously flattened, or rounded. A receptaculum separates the neck from the body. Neck long and tubular with the head retractile into the receptaculum. Head square with four bothridia, terminal, prominent, situated in the shape of a cross, oval, convex, joined at the base by a membrane. Proboscides four, traversing the bothridia in the middle line longitudinally, starting from the apex, very long, armed spirally. Mouth terminal, at the base of the bothridia. Genital organs none.

'On surface of viscera of sea fishes of tropical America ; often enclosed in a single follicle or capsule.'

This is clearly a larval form and is figured as such by Diesing ; in form and appearance it resembles Bremser's drawing of '*Anthocephalus macrourus* Rud.,' *i.e.* *Gymnorhynchus reptans* Rud., and it is certainly the same worm as Linton's *S. filicolle.*

Diesing, in the same paper, changed the name of his genus *Synbothrium* to *Syndesmobothrium*, which he redefined as follows :—

Syndesmobothrium (Diesing, 1850) Diesing, 1855.

Body taenia-shaped, segmented ; neck tubular, rounded at base. Head square, with four terminal, prominent bothridia, placed in the shape of a cross; oval, convex, joined together by a membrane at base. Proboscides four, traversing singly and in the centre, the bothridia, starting from the apex; armed, long, retractile. Mouth terminal at the opening of the bothridia. Genital apertures marginal (?); in intestine of sea fishes of tropical America.

Diesing in 1863 re-classified the Cestoda and gave the following definitions :—

Order CEPHALOCOTYLEA

Section I. PARAMECOCOTYLEA.
Tribe I. *Paramecocotylea. Aprocta.*
Sub-tribe I. *Atrypanorhyncha.*
With 7 families.
Sub-tribe II. *Trypanorhyncha.*
Family 1. *Dibothriorhynchus*
Genus *Rhynchobothrium.*
Family II. *Tetrabothriorhynchus.*
Genera :—*Tetrarhynchobothrium.*
Syndesmobothrium.
Tribe II. *Proctucha* = *Linguatulids.*

Section II. CYCLOCOTYLEA.
Tribe I. *Aprocta.*
With 2 families.

Tribe II. *Proctucha.* *Lucusque ignota.*
Sub-tribe *Trypanorhyncha.*

Head furnished with 4 gimlet-shaped proboscides, armed, retractile into the neck, with 2 or 4 bothridia. Evolution by metagenesis.

Family *Dibothriorhyncha.*

Not defined by Diesing.

Genus *Rhynchobothrium.*

Body segmented, taenia-shaped. Head continuous with the neck, with two bothridia which are opposite each other parallel and converging at the apex ; lateral or marginal, entire or cleft into two parts by a longitudinal septum ; four armed proboscides, thread-like, retractile into neck, slightly longer than head ; mouth terminal. Neck tubular. Genital apertures marginal in the male, lateral in female, or both marginal. In intestinal tract of sea fishes, more rarely in other organs. Evolution of metagenesis.

Family *Tetrabothriorhyncha.*

Body segmented. Head separated from the body by a tubular neck, with four lateral bothridia placed opposite one another in pairs; or terminal and prominent, placed in the shape of a cross and joined at the base by a membrane; four armed proboscides, free, each one traversing a bothridium. Neck tubular. Apertures of genital organs marginal and lateral. In intestines of sea fishes. Evolution by metagenesis.

Genus *Tetrarhynchobothrium.*

Body segmented. Head with four lateral bothridia placed opposite one another in pairs; four free proboscides. Apertures of genitalia marginal or lateral. In intestines of sea fishes. Evolution by metagenesis.

Genus *Syndesmobothrium.*

Body segmented, neck tubular, rounded at base. Head square, with four terminal prominent bothridia, oval, slightly convex, joined at the base by a membrane, placed in the shape of a cross. Four thread-like proboscides, each one traversing the middle of the bothridium, long and retractile into neck. Apertures of genitalia marginal (?). In intestines of sea fishes of tropical America. Evolution by metagenesis.

Larval *Trypanorhyncha.*

Family *Dibothriorhyncha.*

Head with two opposite lateral bothridia, more rarely marginal, entire, or divided into two by a longitudinal septum, or split into two lobes. Four proboscides retractile into neck. Neck tubular, sometimes stained with red. No segments, or perhaps only one retractile into neck. Evolution within blastocysts, aperture visible or closed; blastocyst adherent to neck and separate. In various organs of sea fishes, more rarely in Salmon, *Cephalopods* and *Molluscs.* Adult worms: species of *Rhynchobothrium.*

Family *Tetrabothriorhyncha.*

A. Head with four bothridia, opposite one another in pairs, ovate-lanceolate or linear, immersed in the head. Four proboscides, retractile into the head. Neck tubular. Evolution within blastocysts, aperture visible or closed; blastocyst sometimes adhering to neck, sometimes separate from neck. No segments or only one retractile into the neck. In various organs of sea fishes, very rarely in intestines, free or in a cyst. Adult worms: species of *Tetrarhynchobothrium.*

B. Head with four terminal prominent bothridia placed in the shape of a cross, joined at the base by a membrane. Four proboscides, each traversing the middle of the bothridium from the apex. Neck long, tubular. Body long, continuous, flattened or slightly rounded. Receptaculum placed between neck and body. Head separated from body by a neck; on the surface of viscera of sea fish often enclosed in a single cyst. Adult worms: species of *Syndesmobothrium.*

It is clear that Diesing in this classification referred all the Tetrarhynchids to three genera which he classified as follows :—

Head with two bothridia : Family *Dibothriorhyncha*; genus *Rhynchobothrium.*

Head with four bothridia :— Family *Tetrarbothriorhyncha.*

(*a*) bothridia lateral = *Tetrarhynchobothrium.*

(*b*) bothridia terminal in shape of a cross = *Syndesmobothrium.*

Carus in 1863 classified the worms thus :—

Class I. *Annulata.*

Class II. *Gephyrea.*

Class III. *Chaetognatha.*

Class IV. *Nemathelminthes.*
- (*a*) *Nematodes.*
- (*b*) *Gordiacea.*
- (*c*) *Acanthocephali.*

Class V. *Platyhelminthes.*
- (*a*) *Turbellaria.*
- (*b*) *Trematoda.*
- (*c*) *Cestoda.*

He divided the Cestoda as follows :—

Family 1. CARYOPHYLLIDEA van Beneden.

One genus only, viz., *Caryophyllaeus* Gmelin.

Family 2. TETRAPHYLLIDAE van Beneden.

Sub-Family (*a*) *Phyllobothridea* van Beneden, = *Tetrabothrium* Rud.

Genera :—*Echinobothrium* van Beneden,
Phyllobothrium van Beneden,
Anthobothrium van Beneden.

Sub-Family (*b*) *Phyllacanthina* van Beneden.

Genera :—*Acanthobothrium* van Beneden,
Onchobothrium van Beneden,
Calliobothrium van Beneden.

Sub-Family (*c*) *Phyllorhynchidae* van Beneden.

'The scolex is always separated from the chain by a neck. The four bothridia are at times in pairs and they correspond with the four armed proboscides which latter can be retracted into a sheath. *Anthocephalus* Rudolphi and *Floriceps* Cuvier are . . . included in *Tetrarhynchus*, and so is *Rhynchobothrius*, the latter being the strobila form of *Tetrarhynchus*. *Gymnorhynchus*, Bremser has armed proboscides.'

Genus *Tetrarhynchus* Cuv.

With the characters of the sub-family; comprising Diesing's genera *Acanthorhynchus*. *Pterobothrium* (*Tetrarhynchus*) *Dibothriorhynchus*, *Tetrabothriorhynchus*, *Tetrarhynchobothrium*, *Synbothrium*, *Syndesmobothrum*, and *Aspidorhynchus* Molin.

Family 3. DIPHYLLIDEA van Beneden.

Genus *Echinobothrium* van Beneden.

Family 4. PSEUDOPHYLLIDEA van Beneden

Genera:—*Ligula* Bloch.
Triaenophorus Rud.
Schistocephalus Crepl.
Bothriocephalus Bremser.
= *Dibothrium* Rud.

Family 5. TAENIADEA (Dies.) van Beneden
(*Cyclophyllidea* van Beneden).

Genera:—*Taenia* (L) Rud.
Cystotaenia R. Leuckart.
Echinococcifer, Weinl.
Hymenolepis, Weinl.
Dipylidium, R.Leuckart

Cobbold (1864), defined the characters of his new family *Tetrarhynchidae* as follows :—

'*Tetrarhynchidae* :—The members of this family are easily recognized by the possession of four armed retractile proboscides attached to the head. The armature consists of several successive rows of sharply pointed recurved hooks, frequently amounting to several thousands. The head itself is usually more or less bilobed, each half supporting either one bipartite bothrium, or else two separate fossae. These cavities are also frequently supported on four petaloid appendages, which vary much in shape in the different species, and also, in the same individual, according to the degree of contraction of tho part. The head and neck are continuous, and usually about the same breadth as the body, the latter being sometimes even narrower than either the head or neck. The body is depressed, filiform, distinctly segmented, and usually of great length in the mature state ; the reproductive orifices being situated at the lateral margin of the joints in an irregularly alternate manner.'

Linton (1889), sub-divided the family as shown below :—

Family TETRARHYNCHIDAE Cobbold, 1864.

(= Sub-tribe *Trypanorhyncha* Diesing, 1863.
Sub-family *Phyllorhynchinae* van Ben).

Sub-family I. DIBOTHRIORHYNCHINAE Mont, 1892.

(= *Dibothriorhynchidae* Dies).

Genus *Rhyncbothrium* Rudolphi, 1819.

(= *Tetrarhynchus* of authors).

'Body taeniaeform. Neck tubular. Head continuous with neck, with two opposite bothria, parallel or converging at the apices, lateral or marginal, entire or undivided, or either bilocular with a longitudinal partition, or bilobed or divided. Proboscides four, terminal, filiform, armed, retractile in the neck, for the most part longer than the head. Genital apertures, male marginal, female lateral, or male and female marginal approximate.'

Genus *Otobothrium* Linton, 1889.[1]

'Body articulate, taeniaeform, head separated from body by a neck. Bothria two, opposite, lateral, each with two supplemental ciliated pits at the posterior free angles. Proboscides four, terminal, filiform, armed, retractile in neck. Reproductive apertures marginal.'

Sub-family II TETRABOTHRIORHYNCHINAE Mont, 1888.

(= *Tetrabothriorhynchidae* Dies., 1863).

Genus *Tetrarhynchus* Rudolphi, 1809.

Bothriocephalus Bartels ?
Rhynchobothrium van Ben. and R. Leuckart.
Tetrarhynchus van Ben.
Aspidorhynchus Molin, 1858.
Tetrarhynchobothrium Dies.

'Body articulate, taeniaeform. Neck tubular. Head with four bothria in two lateral pairs, parallel with the head. Proboscides four, terminal, filiform, armed, retractile in the neck, free, *i.e.*, not running through the bothria. Genital apertures marginal or lateral.'

Genus *Syndesmobothrium*, Diesing, 1854.

'This genus is characterised by Diesing as follows :—Body articulate taeniaeform ; neck tubular, rounded at the base ; head tetragonal, with four terminal prominent bothria attached to head by posterior margin, cruciformly disposed, oval, slightly convex, joined with each other at the base by a membrane ; proboscides four, filiform, armed, each one running through a bothrium (pedicel) excurrent at apex, long, retractile in the neck. Genital apertures marginal (?). In the intestines of marine fishes of tropical America.'

Loennberg, in 1889, erected *Coenomorphinae* as a sub-family of the TETRARHYNCHIDAE. Type and only species *C. grossus* (Rud.) = *T. linguatulus* (van Ben.) = *T. solidus*, Drummond, 1838. Larvae have been recorded in Decapods.

The principal characters of the sub-family are :—(1) the presence of a double set of genitalia in each segment, and (2) the fact that the worms are very stout and muscular.

Vaullegeard in 1899 published a very able revision of the Tetrarhynchids and his work deserves to be much more widely known than it is at present. He concludes that the Tetrarhynchids form such a homogeneous group that their division into genera is well-nigh impossible. But he divides them into two sections, viz :—

I. *T. lingualis* section.

This includes all those species in which the larva is not contained within a vesicle and in which the head is terminated posteriorly by a

1. In the present paper, the characters of the latter genus are emended, so as to accommodate *O. balli* n. sp. in which the ciliated pits are not posterior, and *O. dipsacum* Linton, 1897, which has four bothridia.

small papilla. He includes *T. megacephalus* in this section because its larva is not vesicular, even though, as he points out, the adult worm differs widely from other species in the section.

The important points about this section are (1) the posterior part of the head is produced into a collar-like structure which overhangs the anterior segments; (2) hooks on the proboscides are numerous, minute, practically all alike and equal in size.

Vaullegeard includes the following species under this section, *T. lingualis* Cuv., *T. bisulcatus* Linton, *T. lintoni* Vaullegeard = *T. tenui* Linton, *T. robustus* Linton, *T. infulatus* Molin (= *Aspidorhynchus infulatus* Molin), *T. coryphaenae* Bosc, and *T. quadrirostris* Goeze.

Between the first and second sections he places a special intermediate section.

This intermediate section he termed the "*viridis*" section and it included :—*T. viridis* Wagener, *T. megacephalus* Rud., *T. caryophyllus* Diesing, *T. tetrabothrius* Van Ben., and *T. crenacollis* Linton.

The above species appear to the writer to have no common relationship beyond the possession of four proboscides.

II. *T. erinaceus* section.

This includes all those species in which the larva develops within a vesicle.

This section is divided into a number of groups as follows :—

(1) *T. tenuis* group including *T. benedeni* Crety (= *T. tenuis* Van Ben. nec Wedl). *T. angusticollis* Carus, *T. gracilis* Rud., *T. gigas* Cuv., and *T. fragilis* Diesing.

The widest differences appear to exist between *T. fragilis* Diesing and *T. benedeni* Crety, so much so that there seems no justification for grouping these forms together. The hooks, the form and position of the bothridia, etc., present the widest variation in the two species named and, as we have seen elsewhere, in *T. fragilis* the larval bladder is often situated in the neck and not posteriorly.

(2) *T. erinaceus* group. This includes *T. erinaceus* and *T. imparispine*, species characterised by the peculiar arrangement of the hooks on the proboscides. It may be noted in passing that the hooks of *Otobothrium crenacolle* Linton resemble closely those of *T. erinaceus*

(3) *T. ruficollis* group, including *T. ruficollis* Eysenhardt, *T. wageneri* Linton, *T. striatus* Wagener. In this group the characteristic features are (1) the long proboscis sacs which are almost two-thirds the length of the head, and (2) the long head which is from one-third to one quarter the length of the entire strobilus.

(4) *T. minutus* group, including *T. minutus* Van Ben, *T. tumidulus* Linton, *T. trygonis brucconis* Wagener, *T. tenuispinis* Linton, *T. trygonis pastinacae* Wagener, *T. rajae megarhynchae* Wagener, *T. hispidus* Linton, *T. heterospinus* Linton, *T. lomentaceus* Diesing, *T. longicornis* Linton, *T. brevispinis* Linton, *T. agilis* Linton, *T. monticelli* Moniez.

These are all small worms measuring up to about 10 mms., except possibly *T. lomentaceus*. In addition he includes in his last group 24 doubtful species.

In his account of the biology of the Tetrarhynchids Vaullegeard points out that the eggs are liberated as a result of the rupture of the segment, either within or outside the body of the host. He was unable to find hooklets in the eggs but he states that in the egg of *T. tetrabothrius* there are four, whilst Linton states that in *T. tumidulus* they are numerous. Vaullegeard's observation that the larva of any one species frequently occurs in several different hosts is well founded. Discussing the general anatomy of the Tetrarhynchids he adds that the (1) vitelline glands encircle the segment, (2) testes are situated both dorsally and ventrally, (3) vas deferens is dorsal to the vagina, and (4) longitudinal muscle fibres are very numerous, often grouped in fasciae, and situated at the junction of the cortical and medullary zones, as Zschokke described for the Phyllocanthiens and Phyllobothriens. "In *T. tetrabothrius* they form two layers, one internal and one external. The outer layer comprises single fibres."

Vaullegeard further adds that there is no real relationship between the groups he enumerates. He believes that the phylogenetically older larvae were without vesicles and had four bothridia, and he rightly notes that as sucking organs the bothridia are ineffective and even degenerate. It is certainly true that the attachment of the parasite to the host is effected primarily by the armed proboscides, and on this account, if for no other, the Tetrarhynchids may be considered as highly organised. It is interesting to note that Pintner believes that the apical sucker commonly found in the larval forms of the *Tetraphyllidea* (and certain *Proteocephala*) is the homologue of the proboscides. There seems to be very little justification for this assumption.

Braun (1900) defined the Order *Trypanorhyncha*, Diesing, 1863, as follows :—

> 'The scolex is divided into head and neck ; head with two or four bothridia and with four retractile and armed proboscides; segmentation complete, segments usually separating off before maturity. Pores marginal or submarginal; uterine pore ? Genitalia as in Tetraphyllidea. Larvae in different marine animals, adults usually in the guts of Plagiostomes.'

He placed the following genera in the family; an abstract of his definitions is given below :—

Rhynchobothrius, Rud.

This is the oldest genus, erected to accommodate the species *Bothriocephalus corollatus* and *B. paleaceus*, Rud. The author only saw drawings of these species. He discusses the question as to whether *B. corollatus* and *Taenia corollata*, Fab., are synonymous, but says too little is known to decide. *R. corollatus* is selected as the type species. It has two simple bothridia with four proboscides at the four corners, each proboscis being furnished with 20 to 30 hooks bent posteriorly.

Dibothriorhynchus, de Blainv., 1824 (as appendix to French translation of Bremser).

The drawing shows an unsegmented cestode with a posterior tubercle, two bothridia each with a posterior longitudinal septum, two short, retractile proboscides armed with small, bent hooks. Later on the worm was named *D. lepidopteri*. The author considers two proboscides a mistake of the observer, or else, according to Loennberg, it was a larval form. Loennberg's observations enable the following emended description to be given :—

'Trypanorhyncha with four, short, thick, club-shaped or half-circular retractile proboscides armed with hooks; and two sessile, powerful suckers; segmentation complete; segments very muscular, always broader than long, not separating off; genitalia double in each proglottis, each set having three pores; cirrus and vagina marginal, uterus ventral. Larvae not encysted; adult in gut of Selachiens.'

Diesing set up another genus *Dibothriorhynchus* for *Tetrarhynchus scolecinus*, Rud., and *T. gracilis*, Rud. (*i.e.*, larval forms), but adult forms have also received the name; they really belong to the genus *Rhynchobothrius*. Thus Diesing's *Dibothriorhynchus* is a synonym of *Rhynchobothrius*.

Tetrarhynchobothrium, Dies.

Type species *T. tenuicolle*, Diesing, but four other species were added to this genus later on.

Characters of the genus are :—Cylindrical neck, four bothridia, four thread-like proboscides, and irregularly alternating marginal pores; ripe segments longer than broad. *Tetrabothriorhynchus*, Dies., is a synonym of this genus.

Aspidorhynchus, Mol.

Contains one species only, viz., *A. infulatus*, Mol. Diesing placed it in the genus *Tetrarhynchobothrium*. Molin's characteristics include the form and position of the bothridia and a telescopic, retractile neck; these characters are not sufficient to justify the retention of genus *Aspidorhynchus*.

Synbothrium, Diesing.

Diesing later on changed the name to *Syndesmobothrium*.

Characters :—Four oval, convex bothridia placed crosswise on the surface of the head and bound together by a basal membrane; four, thread-like proboscides, which traverse the longitudinal axes of the bothridia and emerge anteriorly. Genital pores marginal. *Synbothrium fragile*, Dies., was for a long time the only species, but Linton described *S. filicolle*, though he has not described it sufficiently, as the specimen was not mature. Host :—*Trygon centrura* (spiral valve).

Abothros, Welch.

Only species :—*A carcharias*, Welch. from *Carcharias*, sp.
Chief characters :—Alleged absence of bothridia; the four, slender proboscides are armed with hooks bent backwards, emerging close together on the ventral surface of the head. Segments very short. Genital pores ? Certain longitudinal furrows could be seen on the scolex, probably the missing bothridia. *A. carcharias*, Welch, is probably identical with *Bothriocephalus bicolor*, v. Nordm.

Otobothrium, Linton.

The only species is *O. crenacolle*, Linton.
Characters :—Two bothridia with longitudinal septum, each of which bears on its free posterior edge, two little suckers. Four thread-like proboscides, pores marginal.

Lühe (1910) defined the Order *Trypanorhyncha* thus :—

'Cestodes whose scolex is usually continued into a *Kopfstiel*; with two or four bothridia at whose apical end are four armed extensile proboscides. When retracted (with the assistance of a retractor which runs in their interior and is inserted into their anterior end) each is drawn back into a proboscis sac. This corresponds in thickness and length with the proboscis itself and represents a direct continuation of the proboscis into the anterior end of the scolex and *Kopfstiel*. At its inner end, the sheath passes directly into the visibly thicker, sharply delineated, egg-shaped or sausage-shaped sac, whose contraction brings about the extrusion of the proboscides. Outer segmentation complete. Formation of segments as in Tetraphyllidea; mature in stomach or spiral valve of Selachiens; larvae found in all kinds of marine animals. In fresh water only a few species are found in the larval condition as parasites of Teleosts. No details of the development of the larvae are known.'

Lühe distinguished two families, *viz.* :—

1. Larva encysted; proboscis long, slender, cylindrical, whole body not massive or muscular.................. *Tetrarhynchidae*,
2. Free larvae, not encysted; proboscis short; almost semi-globular or club-shaped; whole body robust and muscular.................................. *Coenomorphidae*,

He ascribed the following characters to the *Tetrarhynchidae*, Cobbold, 1864 :—

'Scolex with long, slender, cylindrical, very mobile proboscides, with two or four very mobile bothridia more or less leaf-like. *Kopfstiel* present. Strobila slender, with little muscular development; often transparent. Segments, when mature, longer than broad, easily detachable; in each segment a single set of genital organs. Uterus apparently without primary pore. Ripe eggs, as in Tetraphyllidea, escape through dehiscence. In spiral valve of Selachiens; larvae in Turtles, Bony fish, Cephalopods and Decapods.'

He added that nothing was known regarding the systematic division of the family.

He defined the family *Coenomorphidae*, Lühe (1910) as follows :—

'Scolex very robust with short, thick proboscides, semi-globular or club-shaped, with two simple bothridia sunk into the scolex like a pit or a split, and with edges which hardly protrude; no *Kopfstiel*. Strobila robust and very muscular, up to 4 mm. in thickness and not transparent; segments when mature much broader than long and not separating off. In each segment there are two sets of genital organs; uterus with a special pore opening ventrally and having its own muscular system. Mature in stomach of sharks; larvae, not encysted, found in bony fish. There is only one genus with one species, viz., *C. grossus* (Rud.) = *T. solidus* = *T. linguatulus*.'

Pintner (1913) in dealing with Tetrarhynchids in general, pointed out that our information relating to the anatomy of the various forms was not sufficient to enable one to deal extensively with the order, as only six species appear to be well-determined, *T. ruficollis*, Eysenh., 1829, being the best known. Specific points are hardly ever mentioned by authors who have hitherto described different species. The principal characters in distinguishing species, according to Pintner, are :—

(1) The scolex; but this is not altogether definite; the length of the part of the bothridium attached to the head is of importance, the peduncle behind the head is included as scolex. (2) The exact number and shape of the hooks. (3) The form of the proboscis sacs. (4) Whether the head is separated from the neck. (5) The general appearance of the worm. (6) The specific characteristics of ripe segments. (7) The presence or absence of a uterine pore.

Pintner identified three groups, *viz.* :—

1. With a true uterine pore present.................... *T. viridis* group
2. With an involuted, apparent pore, not found in anterior segment.................................. *T. ruficollis* group
3. Segments dehiscent, no uterine pore either primary or secondary................................ *R. tenuis* group

He defined a number of genera as follows :—

Eutetrarhynchus, Pintner, 1913.

'Scolex very long and slender, with small proboscides. The two flat, plate-like *bothridia* are deeply embedded (in lateral view) and inclined to the long axis at about 45°. Proboscis bulbs at least twice as long as the rest of the scolex; in this respect they resemble *T. longicollis*. The proboscides are very long and thick and are covered with a pile of small uniform hooks which look black in low magnifications owing to their small size, but this is not so when highly magnified. Proboscides not longer than proboscis sheath. The retractor lies in the fundus of the proboscis sac and is formed of parallel, closely arranged fibres in which the large constituent cells, for their whole length, and in large numbers, are arranged on one side. The very long sacs are formed of only five or six broad shells of clearly striped, transverse muscle bands, in a single layer, with large spherical myoblasts arranged on the inner side of the sacs in the form of stripes. Neck short;

chain weak but markedly craspidot, seldom apolytic. Generally one or two very mature segments, or longer pieces of greater age, become detached from the chain. Frequently they retain the primary end segment. Segments at the end of the chain sometimes longer than broad. Genital pore in the middle of the margin; apparent uterine openings in the middle line on a level with the pore. The oviduct opens far in front into the uterine sac. Testes large and very numerous, occupying all the segment. Type species :—*Eutetrarhynchus ruficollis* (Eysenhardt, 1829). *E. leucomelanus*, Shipley and Hornell, 1906, also belongs to this genus.'

Stenobothrium, Diesing, 1863.

'Four bothridia (two dorsal and two ventral) whose sides are furnished with very long (but not projecting) hairs; proboscides very long. In *S. macrobothrium* they are the longest of any known *Tetrarhynchid*, being several times as long as the rest of the cephalic region. Scolex markedly craspidot; proboscides weak, short, thin and thread-like, with uniform, not numerous, small hooks, rather far apart. The sheaths are correspondingly thin and short and they bear small sacs. The sacs are formed of very numerous thin muscles in six shells, each of which consists of many muscle layers, the innermost being the thinnest. In transverse section the sac muscles appear not to be arranged as usual, but to lie parallel, like four horses racing behind one another, whereby the thinnest part of each muscle represents the head and the thickest part the hind end of the horse; retractor one-celled. A single, large, constructive cell occurs between the fibrillae, and these have no nuclei; their surface is covered with minute (chitin-like ?) papillae. Frontal glands powerfully built. Strobila strongly developed. Even the last segments are broader than long, with completely smooth sides, laterally limited by a straight line. Genital cloaca situated at the anterior end of the segment towards the ventral side; the long cirrus sac stretches the length of the anterior margin of the segment, its end being bent backwards. Uterine openings in the middle line behind one another. Vitelline glands not so dense as the testes generally are, because the ventral sides are occupied by the coils of the uterus. Ovary of two dorsal and two ventral wings, which, on each side, are sub-divided into five or six lobes; the tubes connecting these sub-divisions are very thin and the wall consists of a single layer of cells; a muscular septum is present at the end of each segment. At the primary hind end (especially in the larva) there projects a conical knob from inside the bladder which is thickly covered with strong hairs, (viz., *S. macrobothrium*) or with papillae (viz., *S. linguale*). Type species :—*S. linguale*, Cuvier, 1817. Other species :—*S. macrobothrium* (Rudolphi, 1819), *T. bisulcatu* , Linton, 1889, *T. tenue*. Linton, 1890, *T. robustus*, Linton, 1890, *S. herdmani*, Shipley and Hornell, 1906, *S. perideraeum*, Shipley and Hornell, 1906. One of Linton's species is probably identical with *S. linguale* Cuvier, 1817.'

Lakistorhynchus, Pintner, 1913.

'Head small and fragile; delicate, fine, and very pointed angle-shaped hooks occur on the soft thin proboscides. Strobila euapolytic or hyperapolytic; the segments grow a lot after separation. They are very long and, in the chain, pass very suddenly from unripe to ripe. The genital atrium is situated in the middle of the segment and is distinguished by a sucker-like pit in front and behind it. The surface of the ripe segments bears marked papillae. The proboscis sheaths afford characters which are peculiar in two ways. Whereas in *benedeni* they are long and form spirals (in connection with a very contractile pars vaginalis) so that the proboscides, even in a completely withdrawn condition, do not approach by a long way the muscle sacs; in *platycephalus* and *rubromaculatus*, on the contrary, the sheaths are short and, therefore, not in sipral, and the proboscides when fully drawn in, actually extend from the part bearing the hooks to the middle of the hollow space of the muscle sacs; consequently, the retractor in them is arranged in very dainty stripes. This divergence in scolex structure can easily be used as of generic importance. At times, also, the species are very peculiar. On the other hand, there is between *benedeni* and *platy-*

cephalus such a similarity in proglottides, and in the case of *benedeni* and *rubromaculatus* such a correspondence in the scolex that I must, for the present, place them in the same genus. Type species :—*L. benedeni*, Crety, 1890. Other species :—*L. rubromaculatus*, Diesing, 1863, L. *platycephalus*, Shipley and Hornell, 1906.'

Halsiorhynchus, Pintner, 1913(1).

'Probably one has to make a new genus for Shipley and Hornell's *T. ruficollis*, type species *H. shipleyanus*, the chief characters are the proboscis hooks and the "coat of mail." It is like a species I described as *Rhynchobothrius vario-uncinatus*. Shipley and Hornell's form has not the slightest resemblance to *T. ruficollis* (Eysenhardt, 1829). The chief characteristic of Shipley and Hornell's species is the armoured chain of proboscides hooks.'

Sphyriocephalus, Pintner, 1913.

'Species thick and muscular; two large, sucker-like bothridia, one dorsal and one ventral, giving the head a hammer-like appearance. Extruded proboscides rigid, thick and straight; proboscis sacs transverse; anterior extremity pointing outwards. The *attenuatus*-group(2) shows the same character, which is also common to the larva, but in the larvae the posterior end of the sacs turn outward. Scoleces craspidot; hooks almost equal in size and in 20 transverse and 16 longitudinal rows. The little hooks measure 0·009 mm. and 0·02 mm., the hooks are slightly larger in the middle, viz., 0·045 to 0·075 mm.; bases 0·048 mm. Eggs in one species are bell-shaped with two enormous processes at the poles, one is long, the other is small (47 to 65μ long and 6μ broad at base) and claw-shaped. Egg 75μ × 47μ, one side being flattened. Type species :—*S. viridis*, Wagener, 1854. Another species :—*S. turgistensis*, Pintner, 1913.'

Otobothrium, Linton, 1890.

'Type species *O. crenacolle*, Linton, 1890. *T. carcharidis*, Shipley and Hornell, 1906, is possibly synonymous with the type species.'

Pintner gave the following synonymy for the species mentioned below :—

Tetrarhynchus *eucomelanus*, Shipley and Hornell, 1906 = *Eutetrarhynchus leucomelanus*.
,, *herdmani*, Shipley and Hornell, 1906 = *Stenobothrium herdmani*.
,, *tenue*, Linton, 1890
,, *bisulcatum*, Linton, 1889 } = All *Stenobothrium* spp.
,, *robustus*, 1890
,, *platycephalus*, Shipley and Hornell, 1906 = *Latistorhynchus platycephalus*.
,, *benedeni* = *T. tenius* = *T. gracilis* = *L. benedeni*.
,, *ruficollis*, Shipley and Hornell, 1906 = *Tetrarhynchus shipleyanus* = *Halysiorhynchus shipleyanus* = *Rhynchobothrius vario-uncinatus*.

1. Pintner considers Shipley and Hornell's specimens of *T. ruficollis* to be synonymous with *T. macrocephalus* Shipley and Hornell. On account of the peculiar hooks on the proboscis of the latter species, Pintner establishes his new genus *Halsiorhynchus*; calling the type species *H. shipleyanus* (= *T. macrocephalus*).

2. *attenuatus* group,
Pintner did not name or define the group; but he included in it the following :—
'Genus *Coenomorphus*, Loenn ; 1889; also *T. attenuatus*, Rudolphi, 1819, *T. grossus* (Rudolph 1819) and *T. megalocephalus*, Shipley and Hornell, 1906.
'*T. equidentatus*, Shipley and Hornell, 1906, also possibly belongs to the *attenuatus* group, or it is a transitional form between the *attenuatus* group and *Stenobothrium*.'

The same author adopted the terminology noted below :—The head is *craspidot* where there is a division between the head and the neck. It is *acraspidot* where the division is absent. Ripe segments are *anapolytic,* when they remain attached to the strobilus. Ripe segments are *apolytic* when they automatically separate from the strobilus. Gravid segments are *euapolytic* when they separate from the chain and continue to grow. Gravid segments are *hyperapolytic* if they separate from the strobilus before they are mature and especially if they do so before the uterus is developed.

It will be seen that Pintner's definitions are very detailed ; so much so that the writer considers them applicable only to the type-species of the genera named, and perhaps one or two other species. Some, or all, of Pintner's genera may ultimately be found acceptable, but in the present state of our knowledge it appears desirable to adopt much simpler generic definitions.

Poche (1926) classified the Trypanorhyncha as follows :—

Class CESTOIDEA.
Subsubclass I. *Amphilinoinei.**
Subsubclass II. *Taenioinei.* *
Order I. *Bothriocephalidea.**
Order II.. *Echinobothriidea.**
Order III. *Tetrarhynchidea.**

The latter order he subdivided as follows :—
Suborder I. *Haplobothriinea.**
Family *Haplobothriidae* Meggitt, 1924,
contains only *Haplobothrium globuliforme* Cooper, 1914.
Suborder II. *Tetrarhynchinea.**
Subtribe I. *Aporhynchoinae.**
Family *Aporhynchidae* contains only
Aporhynchus norvegicus (Nybelin, 1918).
Subtribe 2. *Tetrarhynchoinae.**
Family *Tentaculariidae** with the following genera:—

(1) *Tentacularia* Bosc (= *Tetrarhynchus* Rud.).
(2) *Eutetrarhynchus* Pintner.
(3) *Tetrarhynchobothrium* Diesing.
(4) *Stenobothrium* Diesing.
(5) *Lakistorhynchus* Pintner.
(6) *Acoleorhynchus**
(7) *Nybelinia* nom. nov. (for *Aspidorhynchus* Molin).

* New

(8) *Synbothrium* Diesing.
(9) *Abothros* Welch.
(10) *Floriceps* Cuvier.
(11) *Wagneria* Monticelli.
(12) *Halsiorhynchus* Pintner.
(13) *Sphyriocephalus* Pintner.
(14) *Dibothriorhynchus* Blainville.
(15) *Otobothrium* Linton.

For reasons already given the genera numbered (2), (3), (4), (5), (6), (8), (10), (12), (13) and (14) cannot be accepted.

Genus (7) has not been defined.

Genus (9) has only been recorded once: the species (*A. carcharias*) is supposed to be without bothridia. Braun (1900) notes that as certain longitudinal furrows were seen on the head by Welch "these are probably the missing bothridia." The genera erected by Pintner are dealt with above. The systematic position of the genus *Wagneria* is quite uncertain. Poche considers that the distribution of the vitellaria and testes is sufficient to justify the placing of the genus in the order *Trypanorhyncha*, but it is well-known that a similar distribution of vitellaria and testes is often found in species within the order *Tetraphyllidea*.

Guiart, (1926) in a short paper reclassified the Tetrarhynchids as follows:

Order RHYNCHOBOTHRIENS Duj., 1845.

Sub-order I. ACYSTIDEA nov.

Contains all *Tetrarhynchids*, the larvae of which belong to *Tentacularia*. Head free, not in a vesicle, bothridia dorso-ventral; proboscides usually rather short, emerging from top of head between bothridia, and armed with small similar hooks. Bulbs short and usually immediately behind bothridia. Neck sometimes has an annular fold or collar.

A. Family *Bouchardidae* nov.

Head short and stumpy, without collar.

Genus 1. *Bouchardia* n.g.

Two cordiform bothridia, neck short; much dilated posteriorly. Segmentation begins immediately behind scolex; genital pores anterior.

Typo species. B. *crassiceps* (Dies., 1850) from *Lophius piscatorius*.

B. Family *Rufferidae* nov.

Head with collar posteriorly, larvae:—*Tentacularia* with evaginated tail.

Genus 2. *Rufferia* n.g.

Four prominent bothridia in two dorso-ventral pairs; neck short, not dilated, non-segmented portion behind scolex.

Typo species. *R. tubiceps* (Leuck., 1819). From Sharks and Rays.

Genus 3. *Pierretia* n.g.

Club-shaped head, with four long and flattened bothridia not easily seen, extending from proboscides to the collar ; neck long and cylindrical.
Type species. *P. carchariae* (v. Linst., 1878). From *Carcharias.*

Sub-order II. CYSTIDEA nov.

Contains all *Tetrarhynchids*, the larvae of which belong to *Anthocephalus.*
Head enclosed in a vesicle ; this vesicle, moreover, may bear a very long caudal elongation. Bothridia dorso-ventral or lateral ; proboscides much longer, armed with hooks often dissimilar ; bulbs generally longer, situated behind head.

C. Family *Vaullegeardidae* nov.

Proboscides continuous, with edges of the bothridia free ; hooks on proboscis dissimilar. Mature segments square and dilated, with a brown stain in centre, caused by uterus full of eggs Larva :—*Anthocephalus*, with very long tail reaching one metre in length.

Genus 4. *Vaullegeardia* n.g.

With characters of family. Type species. *V. moniezi* (Railliet, 1899). Probably a parasite of *Oxyrhina spallanzani*, the larva of which appears to be the famous *Acanthocephalus gigas* from muscles of *Brama raju*

D. Family *Lacistorhynchidae* nov.

Proboscis hooks different on each side ; neck dilated at level of bulbs ; mature segments with longitudinal ridges, sometimes very elongated, sometimes cylindrical ; segments live a long time after becoming detached. This has caused them to be taken for *Cestodaria* (genus *Wagneria*). Larvae *Anthocephalus* with small tail.

Woodland (1927) united the Orders Tetraphyllidea and Trypanorhyncha, together with the family Proteocephalidae, into one order, viz., Tetraphyllidea (*sens nov.*).

He stated that the Trypanorhyncha (which he referred to as the family Tetrarhynchidae Cobbold) have the following characteristics :—

Head with 4 proboscides, a distinct internal layer of longitudinal muscle bundles, concentrically arranged vitellaria, and a vagina situated ventrally to the uterus and cirrus sac.

Woodland based his statements on the examination of two species only. The vitellaria are usually arranged concentrically, but in a few cases they definitely consist of two marginal strands only. The logitudinal muscle fibres are not always distinct or internal. In some species the fibres are scattered through the cortical parenchyma, whilst in other species they are collected into large bundles which occupy the major portion of the cortex. It remains to be seen whether the vagina is constantly situated ventral to the uterus and cirrus pouch or not.

Woodland also suggests the inclusion of *Adelobothrium aetiobatidis* Shipley, 1900 (=*Tylocephalum marsupium* Linton, 1916) in the family *Tetrarhynchidae* merely because the vitelline glands are concentric, and in spite of the fact that the head does not bear proboscides.

Pintner, (1928) suggested the following classification of the Class Cestoidea, Rud :—

Order 1. Amphilinidea. (Monozootic forms)
Family Amphilinidae
„ Gyrocotylidae

Order 2. Cestodes, s. str. (Polyzootic forms)
Family Bothriocephalidae
„ Echinobothriidae
„ Tetrarhynchidae
„ Tetraphyllidae
„ Proteocephalidae
„ Taeniidae
„ Discocephalidae
„ Tetragonocephalidae
„ Cephalobothriidae
„ Balanobothridae

It will be seen that the old Orders Pseudophyllidea, Cyclophyllidea, Tetraphyllidea and Trypanorhyncha are merely reduced to the status of families. A new family is erected for Echinobothrium and the old family Lecanocephalidae is split up into four families. Although Pintner does not define his Orders and Families it is clear that the scheme has much to commend it.

Essex, (1928) records from the livers of 5 specimens of *Amieurus nebulosus* taken from the Mississippi, Minnesota, 8 cysts measuring about 700 μ by 660 μ; each cyst containing a larval cestode possessing 4 protrusible proboscides without hooks or spines, and, so far as could be ascertained, without accessory bothria or acetabula. The character of the scolex suggests that the larvae probably belong to the order *Trypanorhyncha*. Apparently, however, it differs from the other species of this order in that the proboscides are unarmed; whether this larval feature persists in the adult worm remains to be seen, and the larva cannot be definitely classified in the present state of our knowledge of this form.

The following is a complete list of genera of Tetrarhynchids which have been described up to date :—

GENUS	AUTHOR	REMARKS
(Hydatula)	Abild. 1790.	
Tentacularia	Bosc 1797.	A larval *Tetrarhynchid.*
Tetrarhynchus	Rudolphi, 1809.	Would include both larvae and adults.
Hepatoxylon	Bosc, 1811.	A larval *Tetrarhynchid.*
Floriceps	Cuvier, 1817.	Adult *Tetrarhynchids.*
Rhynchobothrius	Rudolphi, 1819.	Genus not defined.
Anthocephalus	Rudolphi, 1819.	A larva with two or four bothridia and a posterior bladder.
Gymnorhynchus	Rudolphi, 1819.	Two bifid bothridia; nude proboscides; a larva with vesiclo in neck and not posterior.
Dibothriorhynchus	Blainville, 1828.	Larval forms.
Rhynchobothrium	Blainville, 1828.	——
Rhynchobothrius	Dujardin, 1845.	Adults; two large bifid bothridia.
Tetrarhynchus	Dujardin, 1845.	Two bothridia; short worms, larvae.
Dibothriorhynchus	Dujardin, 1845.	Short, sac-shaped, unsegmented, with globular proboscides.
Tetrarhynchus	van Beneden 1849.	Adults; four bothridia.
Acanthorhynchus	Diesing, 1850.	Two bothridia; cystic form with bladder posterior.
Pterobothrium	Diesing, 1850.	Four bothridia ; terminal ; shaped like a cross ; larval *Tetrarhynchids.*
Dibothriorhynchus	Diesing, 1850.	Two bothridia ; a larval form.
Tetrarhynchus	Diesing, 1850.	Two bothridia, each divided into two by a septum ; a larval form.
Tetrabothriorhynchus	Diesing, 1850.	Four bothridia, ovate-lanceolate; a larval form.
Stenobothrium	Diesing, 1850.	Four bothridia ; a larval form.
Rhynchobothrium	Diesing, 1850.	Two bothridia ; adult worms.
Tetrarhynchobothrium	Diesing, 1850.	Four bothridia, lateral ; adult worms.
Synbothrium	Diesing, 1850.	Four terminal bothridia arranged in the shape of a cross, adult worms.
Aspidorhynchus	Molin, 1850.	Diesing placed it in his genus *Tetrarhynchobothrium.*
Syndesmobothrium	Diesing, 1855.	Four terminal bothridia, arranged in form of a cross, adult worms.
Abothros	Welch, 1876.	Without bothridia (?) but with four proboscides emerging from ventral surface of the head.
Otobothrium	Linton, 1889.	Four bothridia each with a ciliated pit.
Coenomorphus	Loennberg, 1889.	Double genitalia in each segment.
Wagneria	Monticelli, 1892.	Of uncertain systematic position.
Eutetrarhynchus	Pintner, 1913.	Two flat spoon-like bothridia ; long slender scolex ; proboscis sacs twice as long as rest of head ; small uniform hooks small strobila.

GENUS	AUTHOR	REMARKS
Lakistorhynchus	Pintner, 1913.	Segments bear papillae; pore middle, head small and fragile; hooks delicate: types *benedeni*, *rubromaculatus*.
Halsiorhynchus	Pintner, 1913.	Hooks "coat of mail" type.
Sphyriocephalus	Pintner, 1913.	Thick muscular species, two sucker-like bothridia, proboscis sacs transverse: hooks 9–75μ. Type *T. viridis*.
Stenobothrium	Pintner, 1913.	Four bothridia, small uniform hooks far apart, strobila strongly developed: pore anterior.
Haplobothrium	Cooper, 1914.	With genital pores on the flat side; segments form secondary segments.
Aporhynchus	Nybelin, 1918.	Proboscides entirely absent.
Acoleorhynchus	Poche, 1926.	For *Tetrarhynchus equidentatus*, Shipley and Hornell.
Nybelinia	Poche, 1926.	For *Aspidorhynchus*, Molin 1858.
Bouchardia	Guiart, 1926.	Larvae, without cyst; neck short, dilated; two bothridia; pores anterior.
Rufferia	Guiart, 1926.	Larvae, without cyst; four bothridia; neck short, not dilated.
Pierretia	Guiart, 1926.	Larvae, without cyst; four long bothridia difficult to see; neck long, cylindrical.
Vaullegeardia	Guiart, 1926.	Larvae encysted; with a tail up to 1 m.; in adult worm mature segments square with brown stain in centre. Hooks dissimilar.
Grillotia	Guiart, 1926.	Larvae encysted: four bothridia; bulbs elongated.
Armandia	Guiart, 1926.	Larvae encysted; two bi-lobed bothridia; strobilus of 3 to 6 segments.
Gilquinia	Guiart, 1926.	Larvae, probably encysted; four bothridia.

It would appear that six distinct genera are, easily recognisable, namely :—

1. *Tentacularia*—with two lateral bothridia which may be entire or divided to a varying degree.
2. *Tetrarhynchus*—with four bothridia lying parallel to strobilus.
3. *Gymnorhynchus*—with four terminal bothridia arranged in the form of a cross; without ciliated pits.
4. *Otobothrium*—in which there are either two bothridia, each bearing a pair of ciliated pits, or four bothridia each with a single ciliated pit.
5. *Coenomorphus*—in which there is a double set of genitalia in each segment.
6. *Haplobothrium*—in which the genital pores are ventral.

Proposed Classification

Until our knowledge of the morphology of the numerous species of Trypanorhyncha has been very greatly extended, the writer proposes the following classification :—

Order TRYPANORHYNCHA Diesing 1863, emend.

Family I. TENTACULARIDAE Poche 1926.

Genera : *Tentacularia* Bosc. 1797.
Tetrarhynchus Rud. 1809.
Gymnorhynchus Rudolphi 1819.
Otobothrium Linton 1890.

Family II. COENOMORPHIDAE Lühe 1910, emend.

Genus : *Coenomorphus* Loennberg 1889, emend.

Family III. HAPLOBOTHRIDAE Cooper 1917.

Genus : *Haplobothrium* Cooper 1914.

[Of uncertain systematic position :—
Aporhynchus Nybelin. 1918.]

The characters of the order, families and genera are given below :—

Order TRYPANORHYNCHA Diesing 1863, emend.

Head with two or four bothridia and bearing four retractile proboscides armed with hooks : segmentation complete. Genital organs as in the Tetraphyllidea, (except *Haplobothrium*). Vitelline glands usually encircling the segment but may be paired and marginal; they lie either external or internal to the longitudinal muscles : the latter are either collected in definite bundles or scattered as separated fibres in the cortex. Primary uterine pores either present or absent. Adults in Elasmobranch fishes and occasionally in Teleosts. Larvae in Teleosts, Reptiles and Invertebrates. With three families :

Family I. TENTACULARIDAE Poche 1926.

Trypanorhyncha with a single set of genitalia in each segment. Genital pores marginal. Worms more or less fragile. Parasitic in marine and fresh water fishes. Type genus :—*Tentacularia*. Bosc. 1797.

Family II. COENOMORPHIDAE Lühe 1910, emend.

Trypanorhyncha possessing a double set of genitalia in each segment. Genital pores marginal. Strobila stout and muscular. Parasitic in marine and fresh water fishes. No species of this family has been recorded from India. Type genus :—*Coenomorphus* Loennb. 1889.

Family III. HAPLOBOTHRIIDAE Cooper, 1917.

This family contains one genus only, with a single species *Haplobothrium globuliforme*, Cooper, 1914. In this worm the scolex of the primary strobilus is reduced and consists of a club-shaped organ bearing four evertible armed proboscides as in other species of Trypanorhyncha. The spines continue over the anterior portion of the scolex. Segmentation commences a considerable distance behind the head, and the segments are few and very much longer than broad. Later on, each of these segments breaks away from the parent strobilus and becomes a separate worm, becoming secondarily segmented, the secondary anterior segment of each fragment bearing a pseudo-scolex in the form of two bothria, one dorsal and one ventral, as in many species of Pseudophyllidea. The borders of the terminal disc of the secondary scolex and of the posterior auricular appendages of both scolex and anterior segments provided with minute spines, which disappear with the appendages further back. This secondary segmentation is marked before each primary segment separates from the original strobilus.

A single set of genital organs in each segment : genital and uterine pores situated on the flat (ventral) side. Vitelline glands and testes in the medullary parenchyma both within the nerve trunks. Testes in two lateral fields, with vitellaria arranged cylindrically around them, leaving clear areas opposite the central genital ducts. Uterus divided into a coiled proximal uterine duct and a large uterine sac.

This species possesses characters which ally it to both the Trypanorhyncha and the Pseudophyllidea. The four armed proboscides are typically Tetrarhynchid, whilst the presence of ventral genital pores and pseudo-bothria at the anterior extremity of the secondary strobilus are Pseudophyllidean.

Found in the intestine of fish, (*Amia calva*), in Canada and America. The worm has not been recorded from India. Type genus :—*Haplobothrium*. Cooper, 1914.

[Genus :—*Aporhynchus*. Nybelin, 1918.

The genus *Aporhynchus* contains only a single species, *viz.*, *A. norvegicus*, (Nybelin, 1918). The characters of this genus are—the entire absence of proboscides; the unpaired vitelline duct forks, the scolex is acraspedot. There are four bothridia : the external seminal vesicle is very muscular : cirrus very thick and muscular; a pseudo-uterine opening present.

Nybelin states that

'On the erection of a new genus within the Order Trypanorhyncha nothing can be said because we lack a practical natural system of classification of this Order. We must content ourselves in this respect with the suggestion of the near relationship between *Aporhynchus norvegicus* and *R. tetrabothrius*.'

As the worm possesses no proboscides its inclusion in the Order *Trypanorhyncha* would appear to require justification.

The worm has not been recorded from India.]

Key to Genera

	A single set of genitalia in each segment........	1
	A double set of genitalia in each segment........	*Coenomorphus*
1.	Gential pores marginal......................	2
	Gential pores on the flat side (surficial)........	*Haplobothrium*
2.	Bothridia without ciliated pits (otocysts)......	3
	Bothridia with ciliated pits..................	*Otobothrium*
3.	With four bothridia.........................	4
	With two bothridia simple or partly divided longitudinally...............................	*Tentacularia*
4.	Bothridia terminal usually in the form of a cross	*Gymnorhynchus*
	Bothridia parallel with strobila................	*Tetrarhynchus*

The classification of the Trypanorhyncha is a matter of very great difficulty, principally because the numerous species within the order are, with perhaps a dozen exceptions, quite inadequately described. A very large number of larval forms have also been recorded, the adults of which are unknown. The Tetrarhynchids form a very homogeneous group varying amongst themselves only in minor details, such as the form and number of the hooks on the proboscides, the relative length of the proboscis sacs, the size of the worm, the size and shape of the terminal segments, the number of testes, the position of the genital pore and uterine pore when present, the arrangement of the muscular system, etc. The anatomical details are of such a restricted diversity that the differences can hardly be considered as more than specific; the

question of including all the species within the group in a single family—*Tentaculariidae* was seriously considered. To do this it would be necessary to reclassify the entire Cestoda along the lines suggested by Pintner 1928, viz., to divide the Cestoda into two orders— (1) Monozoic Cestodes, and (2) Polyzoic Cestodes. The latter order would contain a number of families such as *Taeniidae, Anoplocephalidae, Hymenolepidae, Tetraphyllidae, Tentaculariidae,* etc.

This scheme of classification appears to be much more satisfactory than many others which have been suggested. Such a simplified system would, however, hardly be in keeping with the methods adopted by many modern systematists. Orders have been erected to accommodate six species; sub-orders and sub-tribes to include a single species in each case.

The difference between these two types or schemes of classification depends on the value which systematists place on a character, or on a combination of characters, and in each case the result is immaterial. What the investigator requires is a scheme, as simple as possible, that will enable him to identify his specimen.

Thus, in the case of the Trypanorhyncha the essential fact is that the worms in this order bear four armed proboscides. It is utterly immaterial whether this character is considered merely of generic value, or whether it is sufficient to warrant the erection of a family or an order.

The point is that if the character is considered merely of generic value then it is difficult, if not impossible, for the systematist to effect those sub-divisions which are so helpful to the investigator; if, however, the character is used for diagnosing a family or order, then suitable sub-divisions are possible.

The broad divisions of the order Trypanorhyncha which have been made by other workers appear well established, and for the sake of utility three families are recognised in this Monograph. Two of these families contain a single genus and species only. All the rest of the Trypanorhyncha fall in the family Tentaculariidae, which contains four genera, that are arbitrarily separated in a purely artificial way. The diagnostic characters of the genera are :—

1. *Tentacularia*—with two bothridia.
2. *Tetrarhynchus*—with four lateral bothridia.
3. *Gymnorhynchus*—the bothridia are either at right angles to the strobilus or pointing anteriorly.
4. *Otobothrium*—ciliated pits on the bothridia.

Having regard to the fact that amongst other things the position of the genital pores in *Haplobothrium* has been considered sufficient to warrant the erection of a family and even a sub-order to contain it, and, similarly, that the presence of double genital organs in *Coenomorphus* are regarded as of family value, one feels justified in considering that the differential characters named above are, if not adequate, at least useful generic distinctions.

We have previously noted that Redi described but did not name a number of larval Tetrarhynchids, and that Goeze described others under the name *Echinorhynchus quadrirostris*: Bosc, however, was the first to separate his species from the genus *Echinorhynchus* and to apply the name *Tentacularia* to those forms with four proboscides. The genus *Tentacularia* is therefore the type-genus of that family of worms which have been included above in the family *Tentaculariidae*. Up to the present no type species of the old genus *Tetrarhynchus*, Rud. 1809, has been designated. It is impossible to decide from Bosc's crude figure of *Tentacularia coryphaenae* whether his species had two or four bothridia. Rudolphi figures the same species under the name *T. papillosus*, and it is likewise impossible to say from his figure whether two or four bothridia are present. According to von Siebold (1850–1851) the adult form of *Tentacularia coryphaenae* is *Tetrarhynchus bicolor* (Nord.), a worm which possesses two bothridia.

Linton (1897) obtained larval forms of *T. bicolor* from *Coryphaena hippurus*, and a number of other hosts. He states, (after Diesing) that

> 'The head is oblong....with four narrow oblong bothria immersed in the head, transversely rugose, and he figures the species as possessing four bothridia.'

The two genera *Tentacularia* and *Tetrarhynchus* are separated in a most arbitrary manner on account of the fact that in the former genus there are two bothridia, simple or partly divided longitudinally, whilst in the latter genus there are four bothridia. This distinction has, however, a very limited morphological significance. The only justification for such a division into two genera is that it facilitates the identification of species. Like every other character it fails in some instances, for, although it is easy to refer worms with two or four bothridia to their respective genus, there are a few species in which each bothridium is only partially divided and it may then become difficult to decide whether there are two or four bothridia.

Another similar complication may arise when a single bothridium fuses with the head, leaving its two lateral margins free, as in *Otobothrium ballium*, n.sp. and *T. matherius*, n.sp. In such cases the four lateral

margins of the two bothridia present the appearance of four bothridia. Such forms as these are to be regarded as intermediate and are difficult to classify.

It has been found necessary to include in the genus *Tetrarhynchus* two species in which the head bears only two bothridia, namely *Tetrarhynchus herdmani* Shipley and Hornell 1906, and *Rhynchobothrium curtum* Linton 1909. The reason why this is so is owing to the fact that the eight known species which are referred to the "*lingualis*" group (see page 257) are very closely related to each other, being characterised by :—

(1) Posterior part of the head overhanging the neck in the form of a collar, and

(2) The hooks on the proboscides being practically all alike and extremely minute, except ? in the case of *T. equidentatus*.

All the species possess four bothridia, except *T. herdmani* and *R. curtum*. It seemed quite undesirable to split up such a very definite natural group as this, and to distribute the species into two genera, namely—those with four bothridia in the genus *Tetrarhynchus*, and those with two bothridia in the genus *Tentacularia*. Therefore these two species, although possessing only two bothridia, are retained in the genus *Tetrarhynchus*.

Family **Tentaculariidae** Poche, 1926

Genus 1. TENTACULARIA Bosc, 1797

Small to medium-sized worms : head with two bothridia lying parallel with the body and having the sucking surfaces facing externally, each of which may be simply emarginate or partly divided longitudinally into two.

Type-species—*Tentacularia coryphaenae* Bosc, 1797.

(a) ADULT FORMS

Tentacularia macrocephala (Shipley and Hornell, 1906). Fig. 3

Tetrarhynchus macrocephalus Shipley and Hornell, 1906.
Tetrarhynchus ruficollis Shipley and Hornell, 1906.
(not Eysenh, 1829).

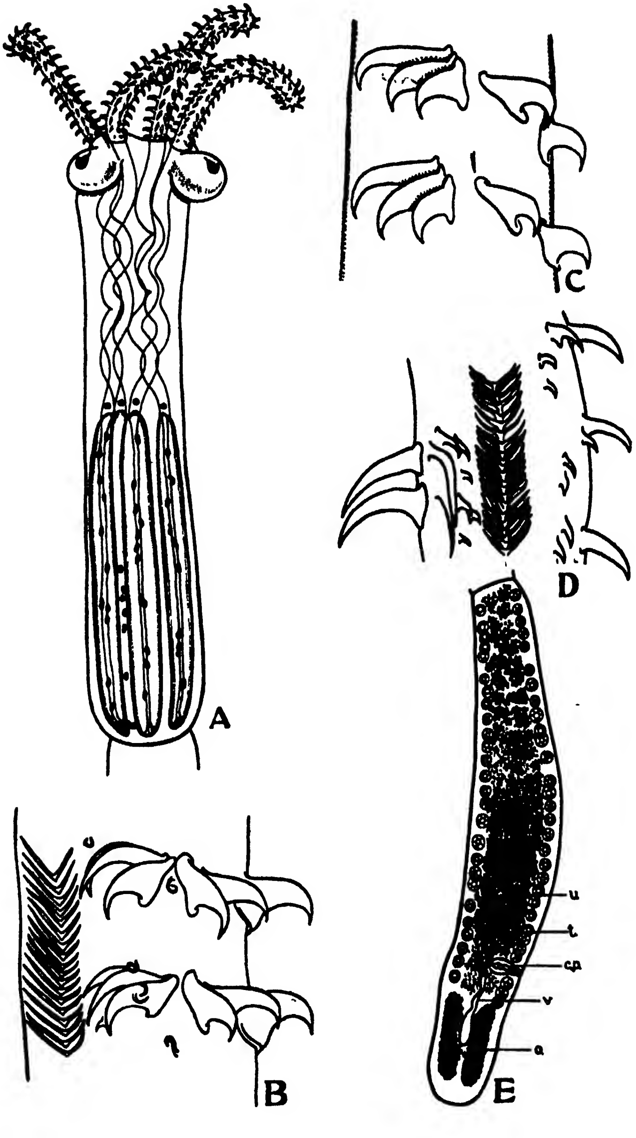


Fig. 3.—*Tentacularia macrocephala*[1]

A—head and neck × 17. B.C—proboscis hooks × 157. D—proboscis hooks × 150
E—nearly gravid segment × 19 (Orig.).

1. For explanation of the reference letters in the text figures see p 307

Shipley and Hornell described this worm as follows :—

'At least six different species of *Tetrarhynchus* are found in the intestine of *Trygon walga*. This species is a short, stout, thick-set form, with large bothridia or lappets, which, however, when the proboscides are extended, are far less conspicuous than when they are retracted.

'The total body length averages 7 millims. or 8 millims., and the body is stiff and straight. The relative length of the different parts of the body in one specimen, whose total length was 8 millims., was 3 millims. for the part of the head traversed by the coiling ducts of the proboscis sheath, 3 millims. for the part of the head which contains the muscular proboscis sheath, and 2 millims. for the rest of the body. The second portion, that which contains the muscular sheath, is the thickest, and its walls are smooth ; the anterior half of the head is wrinkled.

'The four proboscides were in some specimens extended, but not fully they attained a length of some 2 millims. Each bears a longitudinal double row of minute, almost straight spines, diverging from one another, the whole producing the effect of a stitch known, I believe, to housewives as "herring-boning." This lies the whole length of the proboscis. There are also very numerous sharply-hooked spines, which lie in transverse rows of some hundred or more in number. Each of these rows consists of some ten or twelve hooks, grading in size from the largest, which is just opposite the "herring-boning," to the smallest, which flank the "herring-boning."

'When the whole is retracted it passes first into the very coiled ducts of the muscular sheaths, which are very apparent in the specimen.

'The strobila is smaller than either half of the head ; the piece immediately succeeding the head is anteriorly concave, and receives into its concavity the convex end of the head. It soon begins to "segment," and the proglottides grow rapidly. They are few in number, and the most posterior, which is about the tenth or twelfth, is almost as large as all the others put together. It shows clearly the exit of the water vascular system. The specimens were probably young ones.'

A very large number of specimens from *Rhynchobatus djiddensis*,[1] Pearl Banks, Ceylon. February 3rd, 1911, and *Dasybatus kuhlii* and *D. walga*, Ceylon Pearl Banks. November 27th, 1910, were obtained by the writer.

External Anatomy. The worms measure up to 50 mm. in length and the maximum breadth of the strobila is about 0·65 mm. It is composed of about 30 to 35 segments, the last one (gravid) measuring 4 mm. in length and 0·65 mm. in breadth. The genital pores are irregularly alternate and situated in the posterior fourth of the segments. There is no neck.

Head. The head measures from 7 to 8 mm. in length ; its breadth across the bothridia is about 1·3 mm., across the proboscis sacs 0·75 mm. and between the proboscis sacs and the bothridia 0·6 mm.

There are two sucker-like bothridia having a diameter of about 0·6 mm. The proboscis sacs have a length of 2 mm. and a breadth of about 0·27 mm. They are marked by fine criss-cross lines. The proboscides

1. The names given to the Fish hosts in the succeeding part of this paper have been determined by the authorities of the British Museum, and are in accordance with the International Rules of Nomenclature.

can be seen running to the posterior extremity of the sacs, and along their course, within the sacs, they bear numerous coarse granules each having a diameter of about 40 to 60 μ. A single granule is also usually present at the exit of each of the proboscides from its sac.

The hooks on the proboscides are of various shapes and sizes, but most of them are large and gross. First, on each of the proboscides there is a conspicuous herring-bone pattern, or marking, running the whole length of the proboscides and this pattern is not composed of hooks, but of markings on the surface of the proboscides.

The arrangement and shape of the hooks are shewn in fig. 3.

The largest hooks measure over 70 μ and the smallest 2 or 3 μ.

Internal Anatomy. The nervous, muscular and excretory systems were not investigated.

Testes and Vas deferens. There are about 60 testes and they fill the entire segment extending posteriorly, on both sides, to the ovary. Each testis has a diameter of about 80 μ. The cirrus pouch extends mediad to the median longitudinal axis, and the cirrus is unarmed.

Ovary and Vagina. The ovary is bilobed and posterior, each lobe being apposed to the wall of the segment and consisting of 15 or 16 large acini. The vagina is short.

Vitelline Glands. The vitelline glands encircle the entire segment, but the lateral acini are most strongly developed.

Uterus. The uterus is a simple bag entirely filling the segment. The uterine eggs measure about 50 μ; they are globular, and are devoid of filaments.

Pintner, who examined the type-specimen, states that *T.macrocephala* Shipley and Hornell is the same as the mature worm measuring 40 mm. to 50 mm. identified by Shipley and Hornell as *T. ruficollis* (Eysenhardt, 1829) and he further states that the worm identified by Shipley and Hornell as *T. ruficollis* (Eysen) is quite a different species from that described by Eysenhardt.

The species is easy to identify on account of :—

(1) The very large head bearing 2 small bothridia.

(2) The presence on one side of each of the proboscides of a "coat of mail or armoured chain," or herring-bone pattern.

(3) The coarse granules scattered irregularly on the proboscides within the proboscis sacs.

Shipley and Hornell described their "*T. ruficollis*" as follows :—

'Several specimens of this worm were taken from the intestine of *Trygon walga*. They measure 40 millims to 50 millims and had the characteristic criss-crossing of the proboscis sheaths. The teeth are not quite so regular as in van Beneden's specimens, and he does not figure any of the posterior proglottides ; these are cylindrical and smooth, the same diameter throughout and eight to ten times as long as they are broad. They are so cylindrical that it is impossible to say whether the genital pore is on the edge or median. There are besides the larger teeth, arranged in more or less oblique rows, two longitudinal chains of very minute tubercles. Van Beneden's specimens came from *Mustelus vulgaris* Müll and Henle, ours came from the intestine of *Trygon walga*, Müll and Henle.'

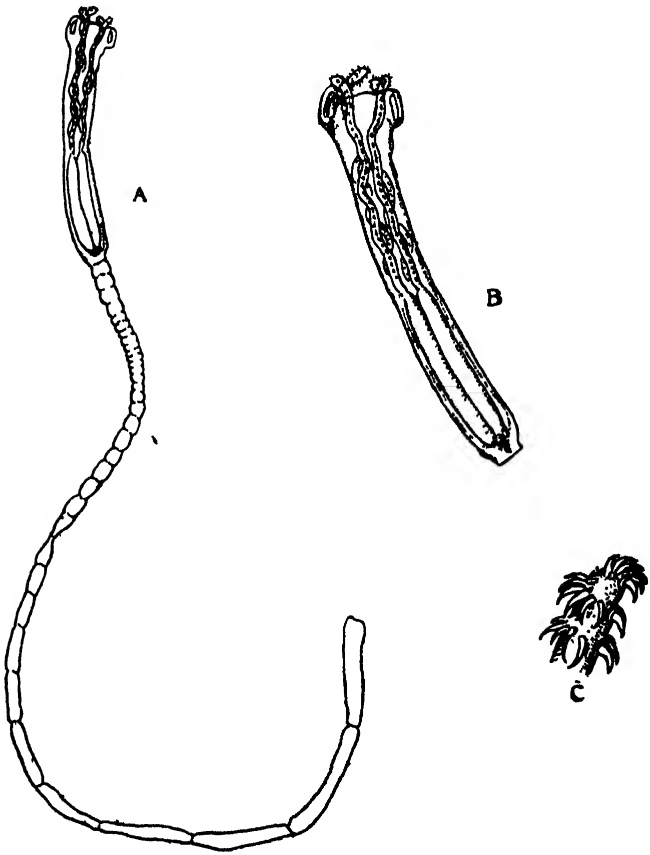


Fig 4.—*Tentacularia ruficollis* S. & H. (? = *T. macrocephala*)
A—entire worm × 6. B—head and neck × 12. C—proboscis hooks. Magnification unknown (After Shipley and Hornell.)

Pintner (1913) considers that *T. ruficollis* Shipley and Hornell, 1906 (not Eysenh, 1829), is synonymous with *T. macrocephala.* (Shipley and Hornell, 1906). On account of the peculiar arrangement of the hooks on the proboscis in the latter species Pintner places the worm in his new genus *Halsiorhynchus* calling the type-species *H. shipleyanus* (=*T. macrocephala* Shipley and Hornell, 1906).

He places *T. leucomelana.* (Shipley and Hornell, 1906) in the same genus. The identity of the parasite named *T. ruficollis* by Shipley and Hornell is doubtful.

Tentacularia macropora (Shipley and Hornell, 1906). Figs. 5 & 6

Tetrarhynchus macroporus Shipley and Hornell, 1906.
Tetrarhynchus annandalei Hornell, 1912.

Shipley and Hornell described this parasite as follows :—

'These are fair-sized Tetrarhynchids, averaging about 25 millims. in length and 1 millim. in breadth.

'The lateral lappets are small, each divided into two, each half corresponding with one of the four hooked proboscides. The head is 6 millims. long and swells out a little behind where the muscular sheaths of the proboscides lie. When alive, there is a patch of pink anterior to these sheaths. Each proboscis bears on its concave side when unrolled a number of strongly recurved teeth, which gradually pass into a much straighter, sabre-like tooth on the convex side. The recurved teeth have a marked anterior process something like a sword-guard, where the tooth passes into the haft, which is embedded in the tissue. This is absent in the more sabre-like teeth. The teeth are in rings, which are obliquely placed.

'There is practically no neck, and the number of the proglottides is small, some 30 to 35. Until the last three or four, the sides of the proglottides are parallel, straight at their ends, and with no sign of overlapping. The whole body is marked by a curious longitudinal striation, which is due to the presence of minute pigment spots, and to the fact that these little brownish particles are arranged along certain longitudinal lines ; also these pigment spots seem broken up into other areas, which give a mottled appearance to the skin.

'The last four or five proglottides are remarkable for the enormous development of the genital pore, which sometimes occupies one-quarter to one-third of the length of the proglottis. From this gaping cavity a minute penis protrudes. These same four or five proglottides lose their uniform shape, and become very irregular in outline. The pores are in all cases lateral and irregularly alternate.' From *Trygon uarnak.*

The writer has examined numerous specimens from the spiral valves *Galeocerdo arcticus*, Twynams Paar, Pearl Banks, Ceylon, 16.12.26 ; *Stegostoma tigrinum*, Pearl Banks, Ceylon, 5.5.24 ; *Dasybatus* sp., Pearl Banks, Ceylon, 24.4.24 ; sent by Dr. Pearson.

As the anatomy of this worm has not hitherto been described, the writer gives the following account:—

External Anatomy. The worm measures up to 6 cms. in length and the greatest breadth is 1·1 mm. There are over 50 segments, the last one measuring 4·5 mm. in length and 1·1 mm. in breadth. The genital pores are irregularly alternate and are situated in the posterior half of

the proglottid. In the fully mature segment the pore is enormous and measures 0·7 mm. in length. This is a very striking character.

There is a short neck measuring 1·8 mm. in length. Details of the nervous and excretory systems were not investigated.

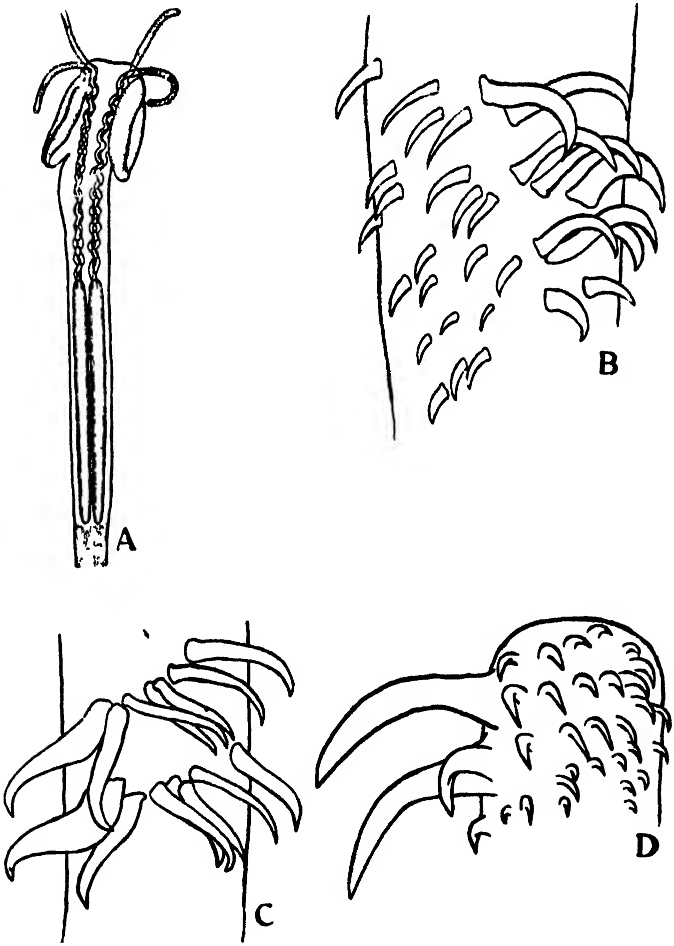


Fig. 5.—*Tentacularia macropora*
A—head and neck × 7. B.C.D—proboscis hooks × 160 (Orig.).

Head. The head measures 9·4 mm. in length and 1 mm in breadth ; in the vicinity of the bothridia the breadth is 2 mm. The proboscis sacs measure 5 mm. in length and 0·4 mm. in breadth. There are two very large bothridia, each having a length of 2·2 mm. Posteriorly they are slightly indented.

The hooks on the proboscides are not arranged in a definite spiral, and they do not extend far backwards on the proboscides.

They are of various shapes and sizes as shewn in figs. 5 and 6.

Internal Anatomy. The muscular system consists of a large number of small scattered fibres situated external to the vitelline glands.

Testes. The testes are numerous and when fully developed each testis has a diameter of about 70 μ. They are all situated anterior to that transverse axis of the segments, which passes through the posterior extremity of the cirrus pouch. When fully mature they are entirely obscured by the dense vitelline glands which encircle the segment, except at the anterior extremity of the segment.

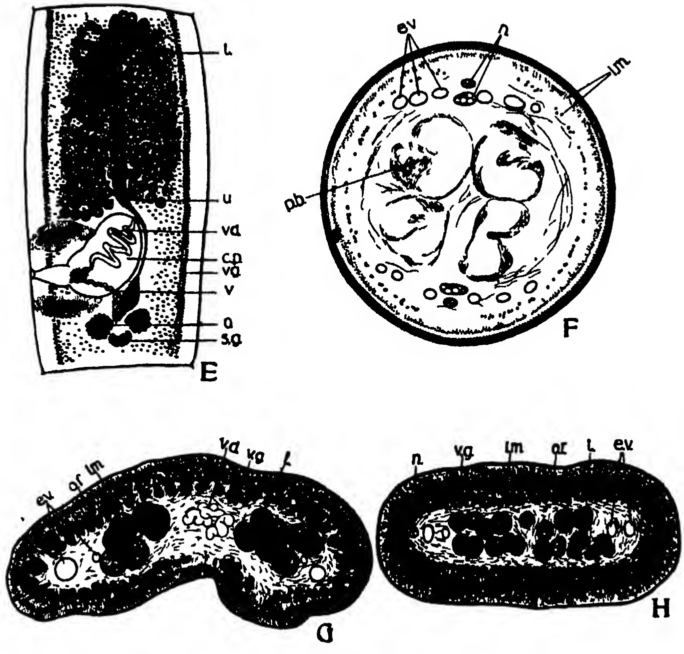


Fig. 6.—*Tentacularia macropora*

E—mature segment × 18. F—transverse section through neck × 56. G—transverse section of mature segment × 56. H—transverse section of nearly mature segment × 56 (Orig.).

Vas deferens. The cirrus pouch is an extremely large and conspicuous structure extending beyond the median longitudinal axis of the segment and displacing the rudiment of the uterus at that point. It measures about 0·7 mm. in length by 0·5 mm. in breadth. Within the pouch the vas deferens presents a striking appearance in being coiled and irregularly dilated, whilst outside the pouch it is equally striking in being

coiled and extending posteriorly towards the ovary. No external seminal vesicle was noted. Marginally, on each side of the pouch, there is a clear space filled with granular material (glands ?).

Ovary and Vagina. The ovary is typically bilobed and prominent. The vagina is short and strongly coiled. Its opening to the exterior could not be seen in total mounts as its terminal portion was obscured by the cirrus pouch.

Vitelline Glands. These appear late and eventually encircle the segment entirely, thus obscuring the testes ; they are strongly developed and prominent.

Shell Gland. This lies posterior to the ovary and is equal in size to one wing of the ovary.

Uterus. The rudiment of this organ extends in the median antero-posterior longitudinal axis. It is bent aporally in the vicinity of the cirrus pouch, because the latter organ extends beyond the median longitudinal axis. No eggs were seen.

Diagnosis. The head of *T. macropora* (Shipley and Hornell, 1906), resembles that of *T. ruficollis* Eysenhardt, 1829(=*T. longicollis* van Beneden, 1849) very strongly. Amongst other points the former species differs from the latter in the possession of an enormous genital pore and cirrus pouch. It should be noted that the appearance of the genital pore varies with the degree of development and with the state of contraction of the segment.

Hornell's description of *T. annandalei* was as follows :—

> 'Length 3·6 cm. Head cylindrical, and fairly long, about 8 mm. Bothridia two, lateral, longer than broad, slightly emarginate on the posterior edge and with a raised and thickened margin. Proboscides four, long, and strongly armed with curved hooks, the majority long and sabre-shaped, fairly stout ; a small number of very minute recurved forms with elongated base present.
>
> 'The proboscis sheaths long and arranged in closely set spirals ; this region of the head including with it the part overlaid by the bothridia is about equal in length to the posterior section containing the contractile sacs. *The latter region is characteristically of great relative elongation* and is slightly wider than the anterior head region. The sacs are cylindrical, with the oblique decussation of the muscle fibres well marked. Neck short, one and a half times as long as wide ; greatest breadth seen in this worm occurs in the anterior part which increases in width abruptly immediately behind the contractile sacs. Neck wrinkled slightly transversely.
>
> 'Proglottides about 25. Anteriorly they are wider than long, but soon become square and then rapidly elongate and in the maturing ones length is twice the breadth. The lateral margins parallel, and none of the proglottides overlap. Cuticle sometimes faintly ringed but this may be a *post mortem* effect.
>
> 'Last five or six proglottides remarkable for enormous development and prominence of the genital pore. This is lateral and situated at beginning of posterior third of the marginal length of each proglottis. Position of the pores are alternate in consecutive groups, usually in alternate series of 3, *e.g.*, right 1, left 3, right 3.
>
> '*Habitat* :—Intestine of *Stegostoma tigrinum* (Gmel.), Bay of Bengal.'

Hornell pointed out that his species differed from *T. macroporus* in that the bothridia are simple and entire in the former, whereas in the latter species each is divided into halves. Shipley and Hornell, however, state that in *T. macroporus* each bothridia is divided into two. In our specimens of this species, whilst the majority of the bothridia are simple as figured by Hornell, in a few, the bothridia are contracted in such a way that superficially each bothridium appears to be, but is not, divided.

Southwell (1924) identified a Tetrarhynchid from *Dasybatus* sp. as *R. erinaceus* (van Ben, 1858) and gave *R. imparispine* Linton, 1890, *R. simile* Linton, 1909, *T. gangeticus* Shipley and Hornell, 1912, *T. annandalei* Hornell, 1912, as synonyms of *T. erinaceus.*

Further investigation, and the examination of a much greater amount of material has shown conclusively that the writer was partly in error on this point.

The specimens named *R. erinaceus* (van Beneden, 1858) proved to be specimens of *T. macroporus* Shipley and Hornell, 1906, (=*T. annandalei* Hornell, 1912), the latter differing from the former in the shape of the hooks and in the size of the cirrus pouch.

R. imparispine Linton, 1890, *R. simile* Linton, 1909, and *T. gangeticus* Shipley and Hornell, 1906, are closely related to, but distinct from both *T. erinaceus* van Beneden, 1858, and *T. macroporus* Shipley and Hornell, 1906.

Tentacularia aetobatidis (Shipley and Hornell, 1906). Fig. 7

Tetrarhynchus aetobatidis Shipley and Hornell, 1906.

'This species, of which we had but two specimens, measures 12 millims. in length. The head is squarish, with two well-marked suckors on each side and the proboscides emerging at the four angles of the anterior surface. These proboscides are perhaps a little stouter and thicker than usual. They bear the hooks in oblique rows. The hooks at the anterior end of the extended proboscides are strongly curved backwards and have a very characteristic haft. There is a prominent projection anteriorly, just where the hook is inserted into the skin. Posteriorly the hooks become more sabre-like.

'One characteristic feature of this species is the swelling which takes place at the posterior half of the head, caused by the presence of the stout muscular bulbs of the proboscis. Just before the junction of the proboscis tubes with the proboscis bulbs are two aggregations of red pigment spots. This region is at least twice the diameter of the succeeding body. There is a short neck, or, at least, a region where no divisions are visible. The number of the proglottides in our two specimens hardly surpassed thirty-five, but the posterior ones were not mature. The proglottides are barrel-shaped. The reproductive pores are irregularly alternate, but, as a rule, there are not more than two consecutively on the same side. The cuticle is roughly ringed.'

(Shipley and Hornell, 1906).

From *Stoasodon narinari*. Shipley and Hornell figure this species as possessing two bothridia.

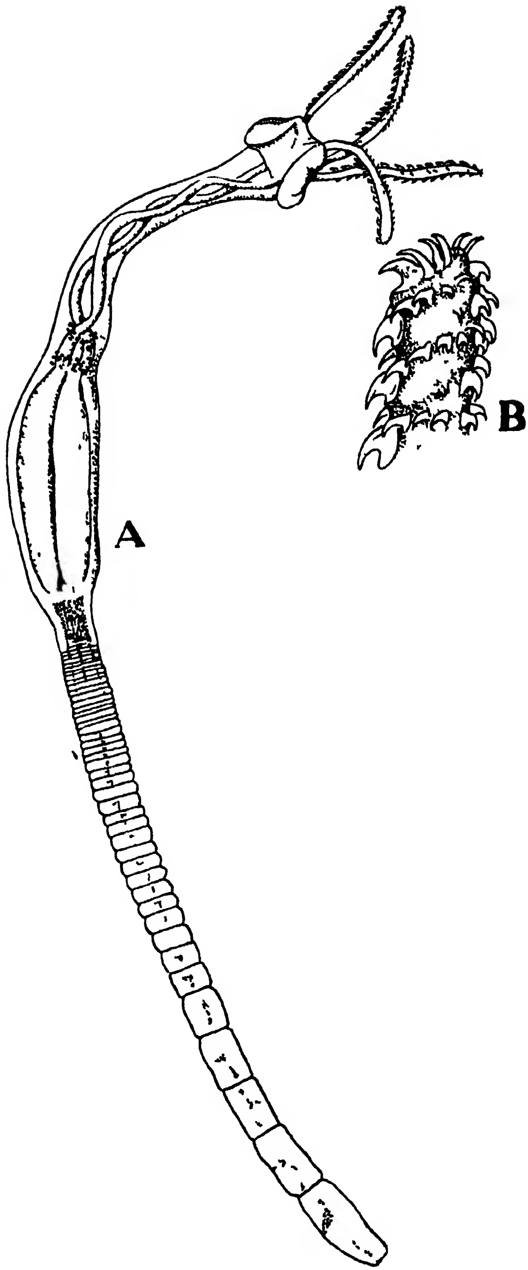


Fig. 7.—*Tentacularia aetobatidis*
A—entire worm × 12. B—proboscis hooks × 100. (After Shipley and Hornell).

Tentacularia rhynchobatidis (Shipley and Hornell, 1906). Fig. 8

Tetrarhynchus rhynchobatidis Shipley and Hornell, 1906.

'The largest specimen of this *Tetrarhynchus* attained a length of 5 centims—but since some loose proglottides measured 4 millims. each, probably the full length is greater—and its posterior end a width of 1 millim. The length of the head is 4 millims. The lappets are short and widely separated; anteriorly they occupy 1 millim., and the remaining 4 millims. are divided equally between the part of the head which contains the proboscis tubes and the part which contains the proboscis bulbs. The part of the head which bears the lappets is 1·2 millims. broad, but behind this the head tapers. The colour of the living specimens is an opaque milk-white.

'The hooks in the proboscides are arranged in longitudinal rows and also in rings. The latter are almost horizontal, there being only a very slight trace of obliquity as they surround the stem. One peculiarity which we have not noticed in other species is that on each proboscis there is a longitudinal row of hooks, whose points are reversed and look towards the tip of the proboscis and not to the base, as do all the others. Some of them are not nearly so hooked as others that pass into sabre-like forms.

'Another peculiarity is that the outer muscles of the proboscis bulb are very oblique, very clear, and cross one another at right angles, giving a "Malvolio, cross-gartered" appearance to these structures.

'There is a short neck, and then a number of proglottides, five or six times as broad as long, separated one from another by perfectly straight lines, and with at first parallel straight sides. They soon, however, begin to lengthen, and at the end of the first quarter they are square. The sides also begin to bow outwards, but the ends are always flat, and there is absolutely no overlapping.

'The reproductive pores are lateral and at the juncture of the anterior two-thirds with the posterior third. Their circular lips are prominent and everted. The pores are irregularly alternate; for instance, starting at the last of one specimen, they run as follows:—1 right, 3 left, 2 right, 1 left, 1 right, 2 left, and so on.' (Shipley and Hornell, 1906).

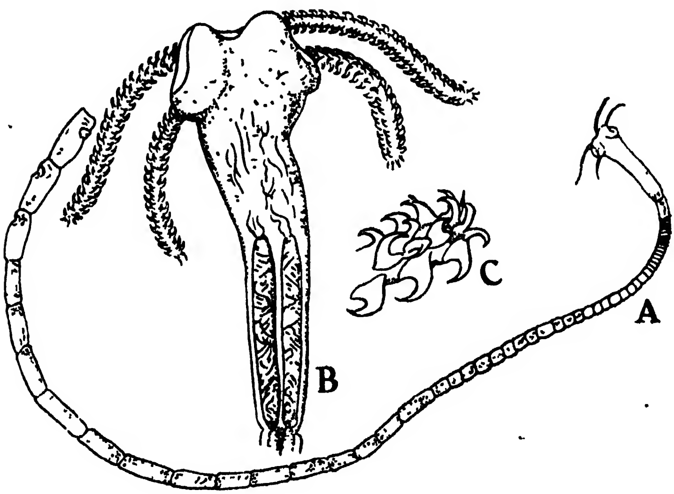


Fig. 8.—*Tentacularia rhynchobatidis*
A—entire worm × 4. B—head and neck × about 18. C—proboscis hooks × 100. (After Shipley and Hornell).

From *Rhynchobatis djiddensis.*

It is possible that this parasite may be recognisable on account of the longitudinal row of reversed hooks on each of the four proboscides. The parasite described by the writer under this name in 1924 has since proved to be a new species which has been named *R. johnstonei.* Shipley and Hornell's figure of the species shews the head bearing two bothridia.

Tentacularia gangetica (Shipley and Hornell, 1906). Fig. 9

Tetrarhynchus gangeticus Shipley and Hornell, 1906.

At least 2 millims. broad, and the head is 3 millims. at least in width. The worm

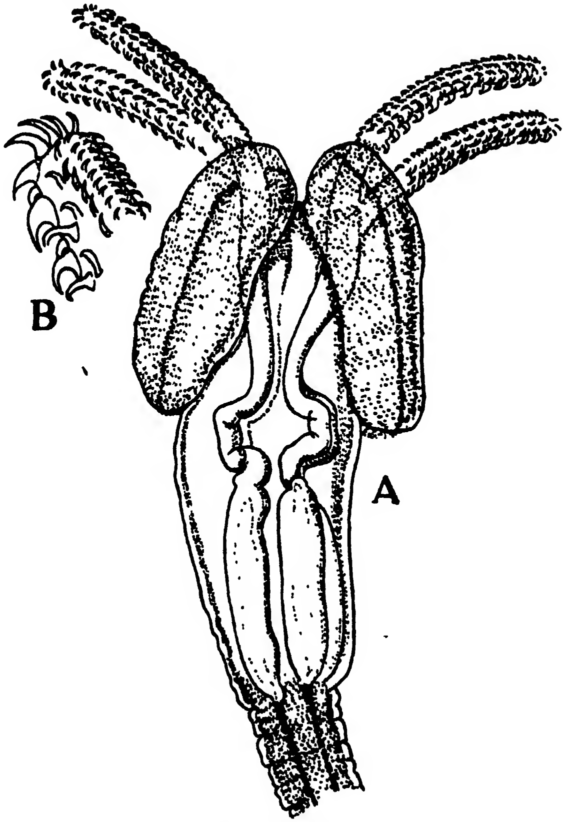


Fig. 9.—*Tentacularia gangetica*
A—head × 20. B—proboscis hooks. Magnification unknown (After Shipley and Hornell).

'Has a smooth, white head, two very clearly defined and large lappets, somewhat heart-shaped, the apex pointing forward and the four proboscides issuing near the two apices, two on each side. The proboscides are stout and bear teeth of many sizes. On the concave side of the extruded proboscis are large, strongly recurved teeth; these are flanked by teeth of lesser size, and they gradually diminish until upon the convex side there are a multitude of fine toothlets; although it is rather masked, those teeth are really arranged in very obliquely placed rings.

'The edges of the lappets are outstanding and sharply separated from the head, and they have clear-cut edges.

'The proboscis-tubes leading to the proboscis-bulbs are not spirally twisted so much as bent in and out. The head narrows posteriorly, anteriorly it is 2 millims. in width, and the whole is 3 millims. in length.

'There is no neck, the proglottides appear immediately after the head. As there were but three specimens, one only was mounted, and this shows only just the anterior five or so proglottides.'

(Shipley and Hornell, 1906).

From *Carcharias gangeticus*.

Pintner (1913) places this species along with *T. herdmani* Shipley and Hornell, 1906, *T. perideraeus* Shipley and Hornell, 1906, *T. lingualis* (Cuvier, 1817), *T. bisulcatus* Linton, 1889, *T. robustus* Linton, 1890, *T. tenue* Linton, 1890, and also *T. macrobothrius* Rud., 1819, in his genus *Stenobothrium*.

T. gangeticus is, however, very different from the other species named above, especially in the absence of a collar and in the hooks being of different shapes and sizes.

Linton (1924), has recorded the larval form from the muscles of *Sciaena hololepidota*, Mossel Bay, South Africa.

Tentacularia carcharidis (Shipley and Hornell, 1906). Fig. 10

Tetrarhynchus carcharidis Shipley and Hornell, 1906.

'Found in the intestine of a *Carcharias melanopterus* taken in Dutch Bay on January 5th, 1905. The length usually 9 millims. The anterior end of the body is extremely thin and whip-like; the body, however, thickens posteriorly until the two last proglottides are 0·5 millims. in thickness. These proglottides are very long, 1·5 millims. and 2 millims. respectively.

'The head is minute, and in stained specimens takes little stain. The two lappets are smooth at their edges, not wrinkled, and with no indentation or sign of division into two. The proboscides are very fine, and bear a number of spines, not hooks. These spines are thicker at the base than at their free end; they all point backwards. They are very minute and seem to be arranged in slightly oblique rings. The proboscis-tubes are very closely coiled, and end in four muscular bulbs, which hardly occupy one-fifth of the total head length. The whole head seems to be dusted through with granules.

'There is no neck. The narrow, band-like proglottides appear immediately behind the head, and they and even the hinder proglottides are separated by quite clear transparent divisions. There are only some eighteen or nineteen proglottides, and we were unable to make out the anatomy of these, as it seemed the material was not very well preserved.

(Shipley and Hornell, 1906.

Pintner (1913) is of opinion that this species belongs to the genus *Otobothrium* Linton, 1890, and further that it is possibly synonymous with the type-species of that genus, viz., *O. crenacolle* Linton, 1890.

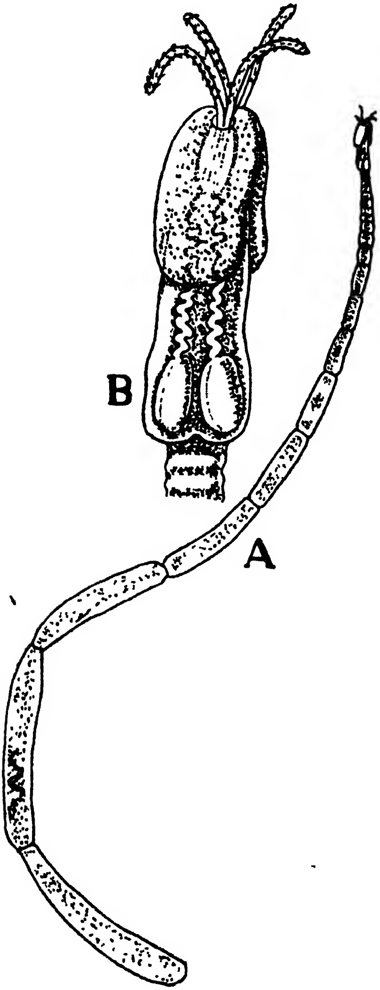


Fig. 10.—*Tentacularia carcharidis*
A—entire worm ×20. B—head × about 40. (After Shipley and Hornell)

Tentacularia leucomelana (Shipley and Hornell, 1906). Fig. 11

? *Tetrarhynchus longicollis* van Ben., 1849.
Tetrarhynchus leucomelanus Shipley and Hornell, 1906.

Numerous specimens from the spiral valve of *Rhynchobatus djiddensis*, Pearl Banks, Ceylon, 3.2.11., T.S., also ten specimens from *Dasybatus kuhlii* Ceylon, 1910, T.S.

Shipley and Hornell gave the following diagnosis of this species :

> 'Five centims. to eight centims. long, with posteriorly thick, stout proglottides, three millims. broad. Anterior half or two-thirds of the preserved body white, the remainder slaty black, deepening into a dense black. When alive, milky white, with a pink patch behind the proboscis sheath. Head with shallow lappets well defined. Proboscides with an enormous number of very minute teeth, all of uniform size and shape arranged in rings and longitudinal rows. The proboscis sacs are very long occupying seven-tenths of the length of the head. There is a short neck: the posterior edge of each proglottis is salient. Generative pores irregularly alternate Habitat :—Intestine of *Trygon sephen*.'

In all our specimens, except one, the strobilus had broken off close to the head so that only a few immature segments were seen. The head is characteristic and can be identified on account of the following points:

1. It measures about 7 mm. in length,
2. The proboscis sacs are usually ½ but sometimes $\frac{7}{10}$ the length of the head.
3. There are two comparatively small bothridia, measuring only 0·36 mm. in length.
4. The free portions of the proboscides are very long indeed and are armed with innumerable minute delicate, slightly curved, sickle-shaped hooks, all alike, but varying in length from about 8 to 15 μ and arranged spirally. Segmentation begins immediately behind the head : the genital pores are irregularly alternate and are situated in the posterior third of the segment. The worm is composed of about forty segments, the last one measuring 1·8 mm. in length and 0·4 mm. in breadth.

Testes and Vas deferens. The testes are numerous and confined to the central field : they extend on both sides to the ovary and are of an oval shape with their axes at right angles to the length of the segment. The cirrus pouch is large and extends over half the breadth of the segment. As usual, the cirrus lies coiled within the pouch : it was not determined whether it was armed or not.

Ovary and Vagina. The ovary is U-shaped, composed of a number of lobes, and is situated at the extreme posterior extremity. The course of the vagina could not be followed as only one strobilus was mature and could not be sectioned, but in one segment it opened ventral and slightly posterior to the cirrus pouch.

Vitelline Glands. The vitelline glands encircle the segment and in whole mounts obscure the anatomy.

Uterus. The uterus was rudimentary and consisted of a central stem. No eggs were seen.

This species is very closely related to, if not identical with, *Tetrarhynchus longicollis*, van Ben., 1849.

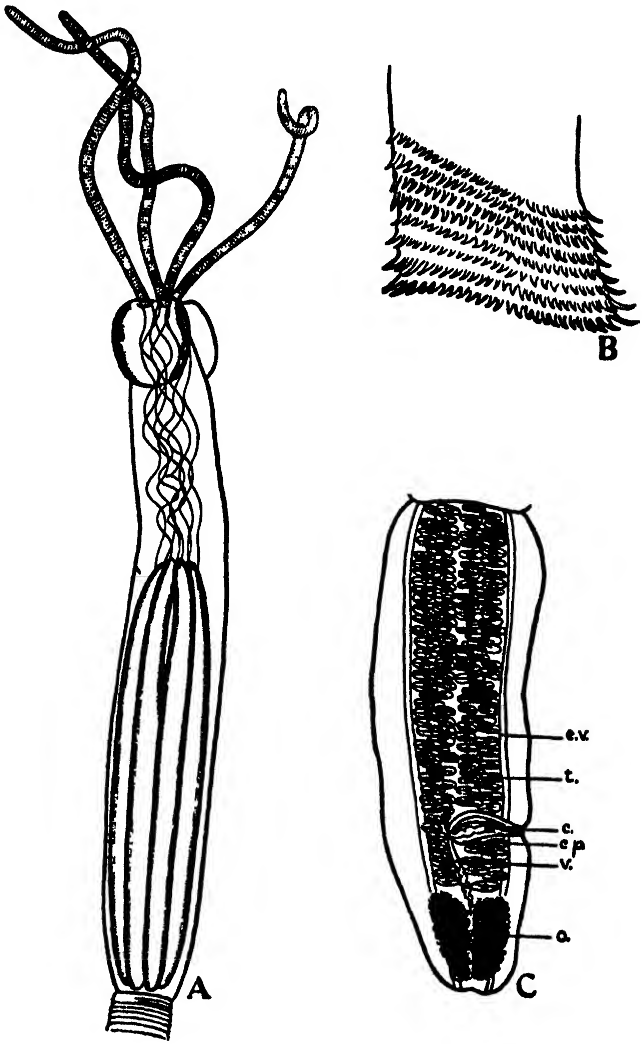


Fig. 11.—*Tentacularia leuccmelana*

A—head and neck × 24. B—proboscis hooks × 232. C—mature segment × 75 (Orig.).

Tentacularia rubromaculata (Diesing, 1863). Fig. 12

Tetrarhynchus rubromaculatus Diesing, 1863.

'This is by far the smallest of the *Tetrarhynchids* found in *Trygon walga*. Only two specimens were taken, one measuring four millims., the other 7 millims. in length. The head occupies nearly half this length, and the proboscis sheaths, which vary a little in the two specimens, are nearly half the length of the head.

'The bothridia are distinct even when the proboscides are contracted. The latter are four in number and bear sickle-shaped spines, not arranged in very definite rows; between some of them are very short rows of minute very straight spines.

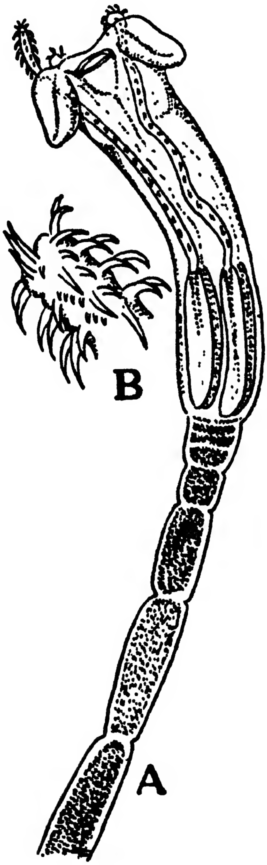


Fig. 12.—*Tentacularia rubromaculata*
A—head and anterior segments × 40. B—proboscis hooks. Magnification unknown. (After Shipley and Hornell).

'Behind the head the body consists of six or seven proglottides; the first two of these are band-like, the third longer, the fourth about square, the fifth twice as long as broad, the sixth and seventh four to five times as long as broad. In one specimen the posterior proglottis bore a lateral eminence, presumably the genital pore, which much resembled the similar process figured by Wagener in a *Tetrarhynchus* taken from a *Trygon pastinaca*.

'In some notes which Mr. Hornell sent with the material he stated that in the bottle which contained the *E. trygonis* were two species of *Tetrarhynchid*, one with collar, and the other with red pigment anterior to the muscle sacs. Now, as a matter of fact, there were four species of *Tetrarhynchids* in the bottle and two of these were collared forms. Thus there is a reasonable degree of probability that the species we are describing, although colourless in spirit specimens, had a reddish patch in front of the muscular proboscis sheaths. In his figure of the *Tetrarhynchus* taken from a *Trygon pastinaca*, Wagener paints a bright red splash just in this place. Neither Wagener's figure nor Diesing's diagnosis, given under the name *Rhynchobothrium rubromaculatum*, descend into any details, which might not apply to many *Tetrarchynchids*, yet there is nothing in the figure nor in the diagnosis which differs materially from what we find in our specimens, and on the whole we seem justified as belonging to the species *T. rubromaculatus* (Diesing).

'Habitat :—The intestine of *Trygon walga*.'

(Shipley and Hornell 1906.)

Pintner (1913) places this species and *Tetrarhynchus platycephalus* Shipley and Hornell, 1906, in his genus *Lakistorhynchus*, the type species of which is *Tetrarhynchus benedeni* (Crety, 1890). He also states that *T. benedeni* = *T. tenuis* van Beneden, 1858 = *T. gracilis* Rudolphi, 1819.

It is very doubtful whether *T. rubromaculata* (Diesing, 1863) can be identified from the meagre descriptions and figures given of it, and it is certain that *T. platycephalus* belongs to a totally different group of Tetrarhynchids. Shipley and Hornell figure this species with two bothridia. Its identity is quite uncertain.

Tentacularia minuta (van Beneden, 1858). Fig. 13

Tetrarhynchus minutus Van Ben, 1858.

Two adult specimens from *Carcharias* sp. Negapatam, India, 7.7.26. Also one adult and several heads with strobila undeveloped from faeces of the same host, Ceylon Pearl Banks, and several heads with strobila undeveloped from *Rhina halavi* Negapatam, India, 3.9.26 and 6.9.26. Dr. Pearson. This is the first record of this parasite in Ceylon. It has been recorded previously from *Squatina angelicus* and *Urolophus testaceus* in Europe.

External Anatomy. The worm measures about 4 mm. in length and the greatest breadth (in a gravid segment) is 0·33 mm.; it is composed of from 3 to 6 segments, usually 3 or 4, the last segment being longer than the rest of the worm and measuring 2·25 mm. in length and 0·27 mm. in breadth. The genital pore is situated in the posterior quarter of the segment. There is no neck.

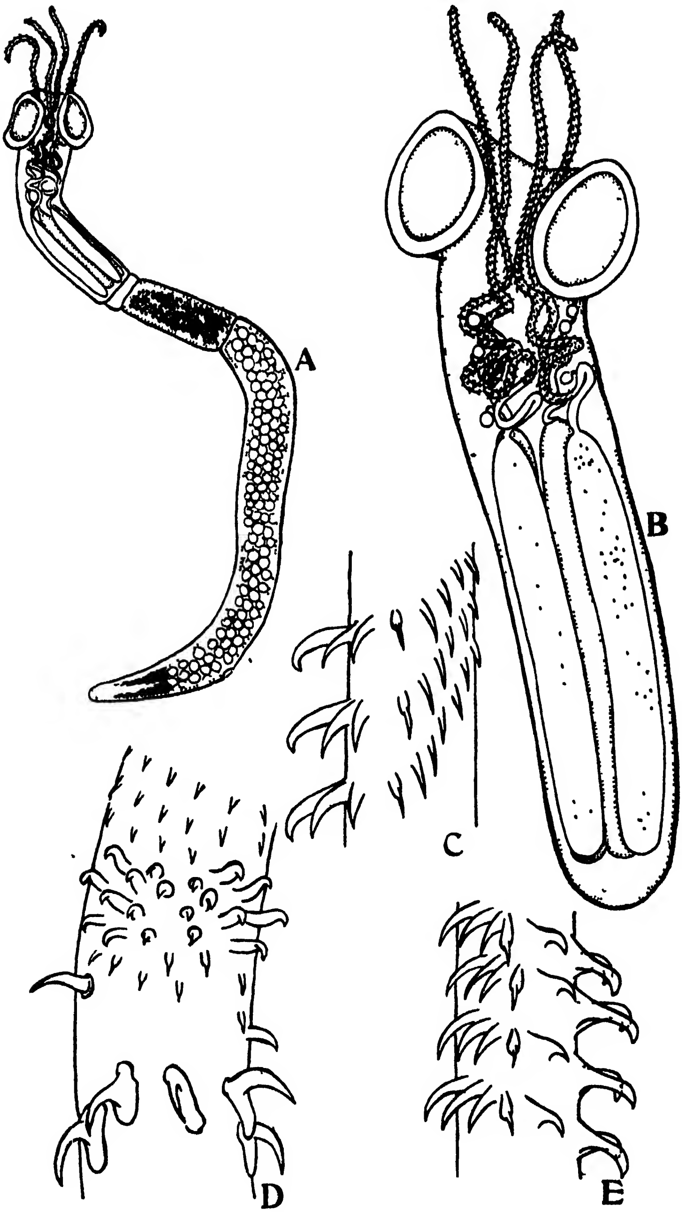


Fig. 13.—*Tentacularia minuta*

A—entire worm × 26. B—larva × 290. C.D—hooks from middle of proboscis × 750. E—basal hooks × 750 (Orig.).

Head. The head has a length of 1·2 mm.; its breadth across the bothridia is 0·4 mm., whilst in the vicinity of the proboscis sacs the breadth is 0·22 mm. There are two sucker-like bothridia each having a diameter of 0·14 mm.

The proboscis sacs are a little more than half the length of the entire head. They vary slightly in length and when the head is contracted, they occasionally extend anteriorly almost to the bothridia. They have a length of 0·63 mm. and a breadth of 65 μ. The proboscides are very coiled within the head, and their free portions are quite as long as the head.

The arrangement and form of the hooks on the proboscides is shewn in fig. 13.

The base of each of the proboscides is swollen and armed with peculiar hooks. This arrangement of the hooks is slightly different from that figured by Scott (1907) for this species. This is possibly due to the fact that Scott, owing to the low magnification used by him, confused the hooks on the dorsal surface with those on the ventral surface.

Internal Anatomy. The nervous, muscular and excretory systems were not investigated.

Testes and Vas deferens. The testes are very numerous and fill the entire field anterior to the ovary. The cirrus pouch and vas deferens could not be seen in whole mounts on account of the fact that they were hidden, as was the vagina, by the testes and the vitelline glands.

Ovary. This is situated posteriorly, each lobe being elongated and apposed to the wall of the segment.

Vitelline Glands. These encircle the segment, but are developed most fully along the lateral margins.

Uterus. This is a simple wide sac entirely filling the segment.

As the species bears two bothridia only it is referred to the genus *Tentacularia.*

In 1904, von Linstow described a new species of *Tetrarhynchus* from the spiral valve of *Taeniura melanospila* caught in Ceylon. Whilst agreeing in dimensions with *T. minutus* (van Beneden, 1858) it differs from that species in the following points —In having 4 bothridia, in the shape of the hooks and in the relative length of the bothridia.

The head shewn by von Linstow in his fig. 70 suggests that his species belongs to the genus *Gymnobothrium.*

Tentacularia spinulifera (Southwell, 1911). Figs. 14 & 15

Tetrarhynchus spinuliferus Southwell, 1911.
Rhynchobothrium laciniatum Yoshida, 1917.

From the intestine of *Rhynchobatus djiddensis*, Ceylon Pearl Banks, 1908.

The worm measures upto 5·5 cms. in length and the greatest breadth is 1 mm. It is composed of a large number of segments, the last measuring about 1·3 mm. in length. The posterior margins of the segments are produced into long digitate flaps with pointed extremities ; these laciniae are small in the neck region and short and blunt in gravid segments. The pores are situated laterally at the junction of the anterior two-thirds and posterior third of the segment. A uterine pore is present on the ventral surface ; the segments do not leave the chain until the uterus is fully mature. The neck is short, measuring only about 250 μ.

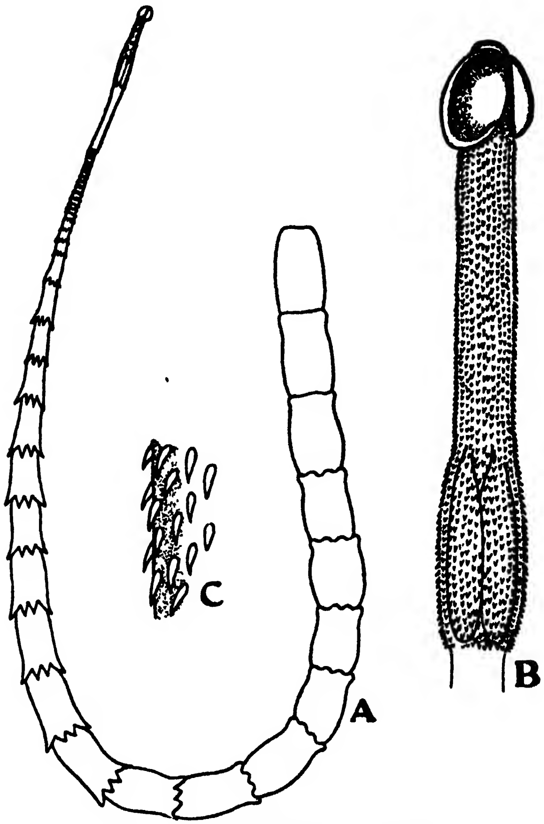


Fig. 14.—*Tentacularia spinulifera*

A—entire worm × 6. B—head and neck × 50. C—proboscis hooks. Magnification unknown. (After Southwell).

Head. The head is very small, measuring 1 mm. in length ; its breadth at the bulbs is 120 μ, and in the vicinity of the sheaths, 76 μ ; the two bothridia measure 126 μ in length and 90 μ in breadth ; the

proboscis sheaths form long, dense, spiral coils, and the proboscis sacs measure 280 μ in length and 27 μ in breadth. Unfortunately, the proboscides were not protruded and consequently details relating to the spines cannot be given. The entire head is covered with very minute spinules.

Owing to the scarcity of material the muscular excretory and nervous systems were not examined.

Testes. The number of testes could not be counted, as the worms were not well-preserved.

Vas deferens. The cirrus pouch is large, extending to the median longitudinal axis of the segment. The cirrus is dilated near the pore, and a number of coils of the vas deferens lie within the pouch. Outside the pouch the vas deferens forms a small coiled mass near the median extremity of the pouch.

Ovary. This is a bilobed organ situated posteriorly and composed of a few, large, club-shaped acini When fully mature the acini appear to fuse on each side, giving the ovary a dumb-bell appearance.

Vagina. Unfortunately, details relating to this organ could not be made out.

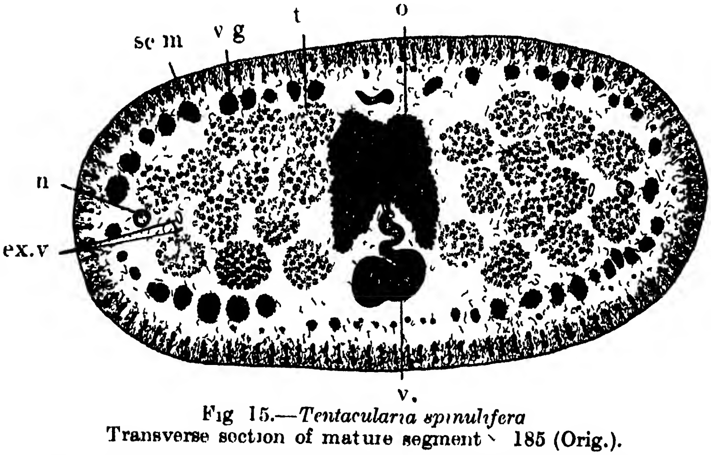


Fig 15.—*Tentacularia spinulifera*
Transverse section of mature segment × 185 (Orig.).

Vitelline Glands. These encircle the entire segment and are composed of large acini.

Uterus. This develops early as a tube with very thick lobulated lateral walls ; it eventually fills the entire segment. A uterine pore is situated ventrally near the median extremity of the cirrus pouch ; it has a muscular margin.

Eggs. No fully ripe eggs were seen, of those observed some were flask-shaped, with a number of short filaments at one end, whilst others were somewhat kidney-shaped, with a number of short filaments at both extremities.

There is no room for doubt that *R. laciniatum*, Yoshida, 1917, is identical with *T. spinulifera* Southwell, 1911.

Tentacularia longispine (Linton, 1890). Fig. 16

Rhynchobothrius longispine Linton, 1890.

One specimen of what the writer believes to be this species was obtained from the spiral valve of *Dasybatus walga*, Pearl Banks, Ceylon, 1910.

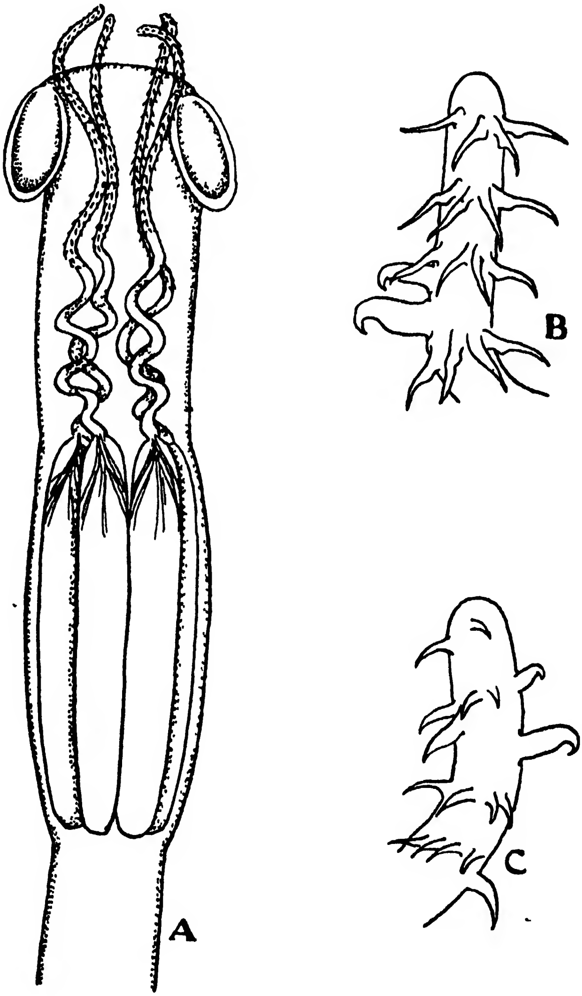


Fig. 16.—*Tentacularia longispine*
A—head and neck × 40. B.C—proboscis hooks × 320 (Orig.).

The worms, which were composed of about 7 segments, measured 6 mm. in length and the maximum breadth was 0·29 mm. The last segment measured 2·5 mm. in length and 0·29 mm. in breadth.

The head measured 1·3 mm. in length ; its breadth across the bothridia was 0·4 mm., across the proboscis sacs 0·3 mm. and between the bothridia and the sacs 0·28 mm. There are two simple, small, bothridia having a length of 0·2 mm.

Only the terminal portions of the proboscides were protruded and the hooks resembled those figured for this species by Linton in size and appearance. Linton's specimens were from *Dasybatus centrura.*

Tentacularia unionifactor (Shipley and Hornell, 1904). Fig. 17

Tetrarhynchus unionifactor Shipley and Hornell, 1904.

From the intestine of *Rhinoptera javanica*, Müll. and Henle, Dutch Bay. They are described as

'Existing in swarms in the stomach, especially at the pyloric end. Very few were found in the spiral intestine. They occurred in all the specimens of *Rhinoptera javanica* captured. The longest was three centims., the other two were about half that length ; but Mr. Hornell states that when alive they can extend themselves to 4 or 5 inches. The head and body are stout, averaging a little under a millimetre in diameter ; the proboscides are very small and fine, and are invisible to the naked eye. They arise apically, close together at the anterior surface of the head, and are supported by two shallow cephalic suckers or bothridia on each side which meet anteriorly. The neck extends for 1 ·5 millims. to 2 millims., and contains the four clearly marked proboscis sheaths and four tubules proceeding from them enclosing the retractor muscles of the proboscides ; these are very convoluted. The proglottides are at first broad and shallow, but they soon lengthen, and in the middle of the body they are cylindrical, three times as long as broad and circular in transverse section ; their posterior border just overlaps the succeeding segments, but only just. Posteriorly the proglottides lose their shape, become baggy, and develop a purplish-brown colour, and here they are 2 millims in length, and rather over 1 millim. in breadth.

'The genital openings are irregularly alternate, there being perhaps two pores on the right side, succeeded by two on the left, then one on the right, and so on.

'The anterior proglottides are very shallow, and lie one upon another like a series of saucers or a pile of developing ephyrae ; when they deepen a little, they have one, rarely two, transverse creases in their cuticle, but as they get to be as deep as they are broad, the number of these creases has very much increased, and the posterior end of the body is quite crinkled.

'The proboscides are armed with hooks which are spirally arranged ; the hooks are not very hooked, and the angle is slight ; further all the hooks are shaped alike and are all about the same size. They are very small.

'The two bothridia are comparatively shallow, but during life their edges are obviously very mobile, and they may deepen or become shallower as occasion arises. Their outline is roughly triangular, one angle being anterior. The angles are very rounded, and the deepest part of the bothridium lies in the posterior angles.'

(Shipley and Hornell, 1906).

From *Ginglymostoma concolor.*

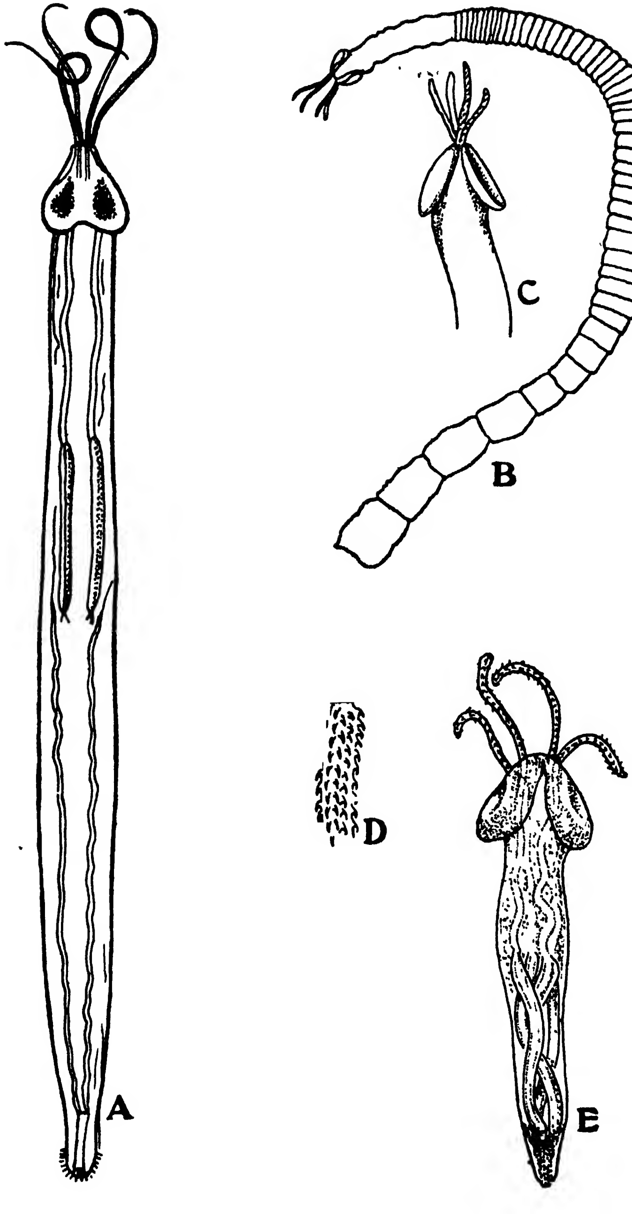


Fig. 17.—*Tentaulcuria unionifactor*

A—larva. Magnification unknown. B—entire worm. C –head. D—proboscis hooks. Magnification unknown. E—larva × about 100. (After Shipley and Hornell).

It is not possible to identify the parasite from the above description. The small hooks, all of the same size and shape, suggest that the worm may belong to the " *lingualis* " group.

It is almost certain that the larval forms named *T. unionifactor*, Shipley and Hornell, 1904, from *Margaritifera vulgaris* belong to the genus *Tylocephalum*, Linton, 1890.

Tentacularia rossii (Southwell, 1912). Fig. 18

Rhynchobothrium rossii Southwell, 1912.

The writer in his original description of this parasite was unable to give an account of its anatomical details. A full description is given below :—The worm has now been obtained from *Dasybatus kuhlii*, *D. walga*, *Rhynchobatus djiddensis* and *Stoasodon narinari*, Pearl Banks, Ceylon. Various dates from 1909 to 1911.

External Anatomy. The worms measure up to 60 mm. in length and the maximum breadth is about 2 mm. There are a large number of segments, which normally have slightly salient margins, but when the worm is contracted this characteristic is much more pronounced in the anterior part of the worm. The largest posterior segment measured 4 mm. by 2 mm. The genital pores are irregularly alternate and situated a little posterior to the centre of the lateral margin of the segment. The worm is very thin and whip-like anteriorly, broadening out rapidly posteriorly. The neck is short measuring about 0·6 mm.

Head. The head varies in length from 2 mm. to 3·2 mm. It has a fairly even breadth of 0·45 mm. both across the proboscis sacs and anteriorly. The posterior part of the head merges insensibly into the strobilus, the junction between the two being marked by the fact that the tissue of the strobilus is denser than that of the head. The proboscis sacs are situated midway between the anterior and posterior extremities of the head ; they measure 0·7 mm. in length and 100 μ in breadth. The proboscides are, comparatively, very short. Within the head they pursue a slightly wavy course. Their free portion, anterior to the head, is also very short ; they are armed with numerous very minute spinules 4 or 5 μ only in length. There are two bothridia, almost circular in outline and having a length of 0·5 mm.

Internal Anatomy. Excretory system. The ventral excretory vessel on each side is large and prominent. The dorsal vessel is extremely small and can rarely be seen, even in sections. The cirrus pouch lies ventral to the dorsal vessel.

Nervous system. On each side there is a nerve running the length of the worm and situated external to the ventral excretory vessel.

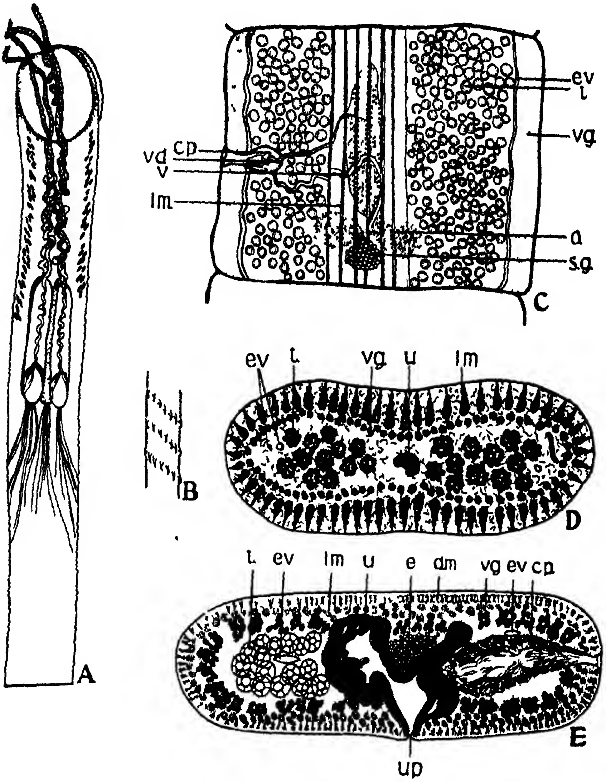


Fig. 18.—*Tentacularia rossii*
A—head and neck × 30. B—proboscis hooks × 400. C—mature segment × 54. D—transverse section of mature segment × 40. E—transverse section of nearly gravid segment × 46 (Orig.).

Muscular system. The cuticle has a thickness of 12 μ. Immediately beneath it is a rather large outer layer of dorso-ventral fibres. Internal to the latter is a single layer of very large longitudinal fibres, median to which lies a few delicate circular fibres. Oblique fibres can be seen ramifying between the longitudinal bundles. The vitelline glands lie internal to the longitudinal muscles.

Testes and Vas deferens. The testes are numerous and are situated laterally, *i.e.* they are absent from the central field. On the pore side,

a number of testes occur posterior to the cirrus pouch. The cirrus pouch is small, 0·18 mm. by 0·145 mm., and occupies ¼ the breadth of the segment. It lies internal to the ventral excretory vessel and opens at the base of a deep pit or genital sinus. The cirrus lies coiled within the pouch and is unarmed. Outside the pouch the vas deferens is very short.

Ovary and Vagina. The ovary is bilobed, or U-shaped with the free extremities posterior; it is situated posteriorly and is granular in appearance. The vagina, just anterior to the ovary, dilates into a receptaculum seminis, and, pursuing a very coiled course opens to the genital sinus, ventral to the cirrus pouch. Posterior to the ovary there is a large and conspicuous shell gland.

Vitelline Glands. These are confined to the lateral margins: in cross section they present a semicircular distribution. The glands are entirely absent from the mid-dorsal and mid-ventral areas. Further they lie internal to the longitudinal muscles.

Uterus. As usual, this arises as a central longitudinal stem. As it becomes gravid, large lateral branches arise on each side. Eventually it fills the segment entirely and opens to the exterior ventrally in the middle of the segment by a definite primary pore.

Eggs. The uterus was full of eggs tightly packed together, making measurement difficult, they measured about 45 μ in length and 22 μ in breadth, and at one pole, they bear 2 or 3 filaments measuring 8–10 μ.

Tentacularia johnstonei n. sp. Fig. 19

Three specimens from the intestine of *Dasybatus sephen*, Ceylon Pearl Banks; collected and presented by James Hornell, Esq.. F.L.S.

The worms are relatively large and stout, measuring up to 50 mm. in length and having a maximum breadth of 1·5 mm. They are composed of numerous rather thick segments, with slightly salient posterior margins, the last segment measuring 2 mm. in length and 1·4 mm. in breadth; the genital pores are irregularly alternate and are situated in the posterior third of the segment.

Head. The head is very small and somewhat heart-shaped, the pointed extremity being directed anteriorly. It has a maximum width of 900 μ and a length of 900 μ. The two bothridia are small, having a breadth of 530 μ and a length of 500 μ; their margins are entire and only slightly thickened. The proboscis sacs are situated almost immediately behind the posterior margins of the bothridia and they have a length of 245 μ and a maximum breadth of 110 μ. The neck measures about 220 μ in length; anteriorly the neck is somewhat thickened and the posterior extremity of the proboscis sacs lie in the thickened portion.

The armed portion of the proboscides and the proboscis sacs are each as about long as the bothridia.

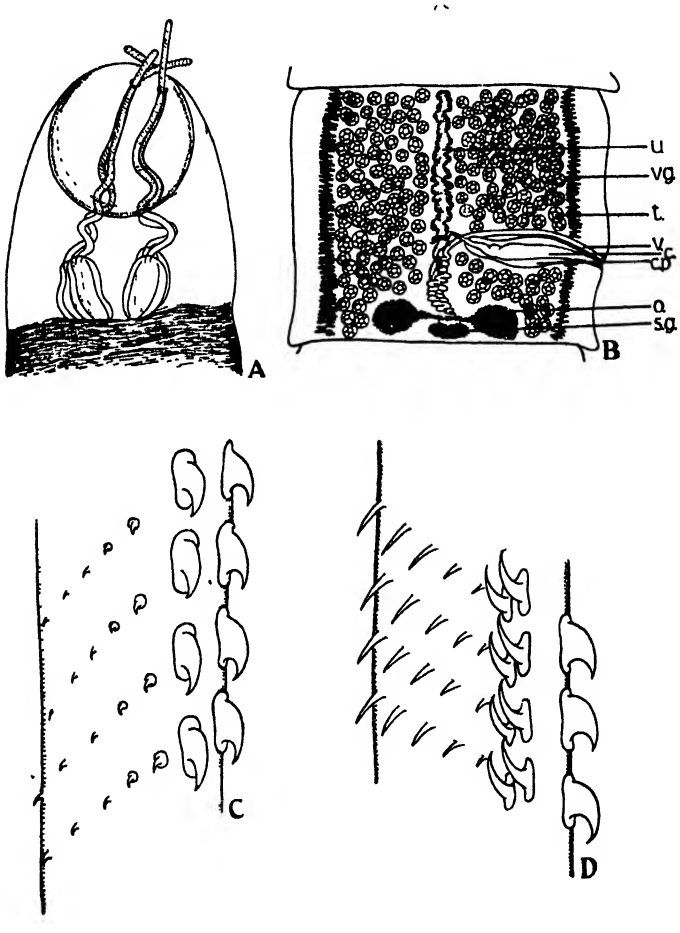


Fig. 19.—*Tentacularia johnstonei* n. sp.
A—head × 46. B—mature segment × 46. C.D—proboscis hooks × 660 (Orig.).

Hooks. The hooks on the proboscides are arranged in spirals. The internal dorsal face of each proboscis bears two longitudinal rows of rose-thorn shaped hooks 10 μ in length arising from a base also 10 μ in diameter. Ventrally there are three or four longitudinal rows of smaller rose-thorn shaped hooks, one or two longitudinal rows of which have their points directed anteriorly.

Muscular system. The longitudinal muscular system is strongly developed and consists dorsally and ventrally of a single row of oval bundles. Laterally the bundles are much smaller and scattered about irregularly.

Excretory system.—This consists of two vessels on each side, the internal vessel is large and the external vessel (which lies directly external and close to the large vessel) is very small.

Details of the nervous system were not investigated. The cortical and medullary parenchyma are strongly developed.

Testes and Vas deferens. The testes are very numerous and fill the dorsal part of the segment in front of the ovary. In the early stages of development they are crowded together in the median field, on each side of the mid-anteroposterior axis. The cirrus pouch is conspicuous and extends one-third the distance across the segment; no spines were observed on the cirrus. Posterior and median to the pouch the vas deferens forms a number of conspicuous coils.

Ovary. This is, as usual, a bilobed organ situated posteriorly; the vagina is a short, coiled tube which runs ventral (?) to the pouch and opens to a shallow genital atrium.

Vitelline Glands. These completely encircle the segment and are situated in the cortical parenchyma.

Shell Gland. This is a conspicuous organ lying posterior to the ovary.

Uterus.—This arises as a closely coiled tube running to the extreme anterior margin of the segment; eventually it entirely fills the segment, and is distended with eggs, none of which, however, were mature.

In a former paper the writer considered this species as identical with *T. rhynchobotidis* Shipley and Hornell, 1906, and also with *R. curtum* Linton, 1909.

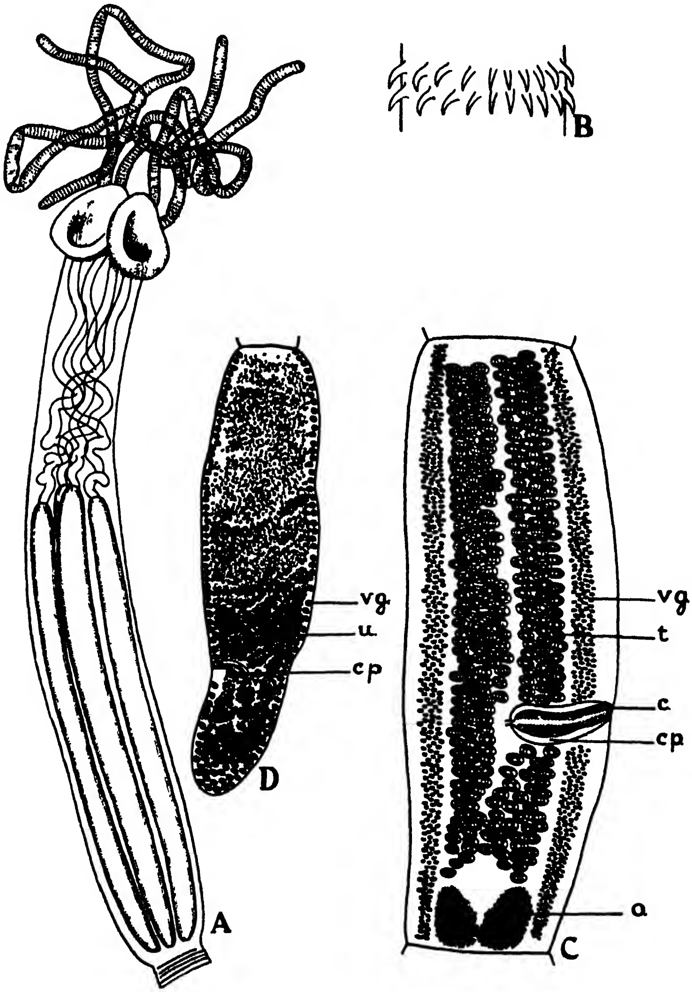
A re-examination of the old, and of fresh material, has proved that the species is quite distinct and also that *R. curtum* Linton, 1909, is distinct from *T. rhynchobatidis* Shipley and Hornell, 1906. *T. johnstonei* n. sp. is differentiated from all other Tetrarhynchids except *T. obesus* by the form of the head and the arrangement of the hooks on the proboscides.

It is named in honour of Professor James Johnstone to whom the author is greatly indebted for much assistance and advice over a period of twenty years.

Tentacularia michiae n. sp. Fig. 20

A few specimens from each of the following hosts: *Rhynchobatus djiddensis*, Ceylon Pearl Banks, 3.2.11. *Dasybatus sephen*, Ceylon Pearl Banks, 2.5.24, Dr. Pearson; and *Dasybatus kuhlii*, Ceylon Pearl Banks, 1911. T.S.

The worms measure 18 mm. in length and the maximum breadth is 0·8 mm. They are composed of about twenty segments. The thirteenth or fourteenth segment is square, measuring 270 μ : the last segment is full of eggs and measures 3 mm. in length and 0·8 mm. in breadth. There is no neck. The genital pores are irregularly alternate and are situated in the posterior third of the worm ; the pores frequently show tumid lips.



Fig, 20.—*Tentacularia michiae* n sp.

A—head and neck × 26. B—proboscis hooks × 500 C—mature segment × 75. D—gravid segment × 23 (Orig.)

Head. The head measures 4·2 mm. in length ; the proboscis sacs measure 2·6 mm. in length and 216 μ in breadth.

There are two small somewhat circular bothridia having a length of 450 μ. The anterior and lateral portion of the head is armed with minute deciduous spines measuring about 6 μ. The proboscides are extremely long, certainly longer than the entire head, and the free portion extending beyond the head is also very long. They are very densely armed with extremely delicate minute hooks, all alike, which measure about 13 μ, giving the proboscis the appearance of being covered with fine fur.

The genital organs call for no comment except that in the last segment all traces of the essential genital organs have disappeared, except the cirrus pouch.

The vitelline glands encircle the segment at the posterior extremity only. The type, mounted, is in the collection of the Liverpool School of Tropical Medicine.

Tentacularia obesa n. sp. Fig. 21

One specimen only from the spiral valve of *Dasybatus sephen*, Pearl Banks, Ceylon, 14.2.08. T.S.

The worm measures 11 mm. in length and has a maximum breadth of 1 mm. For its length it is a very stout fleshy worm. It is composed of about 30 segments, of which about 20 immediately posterior to the head are very small and can only be counted under low power magnification.

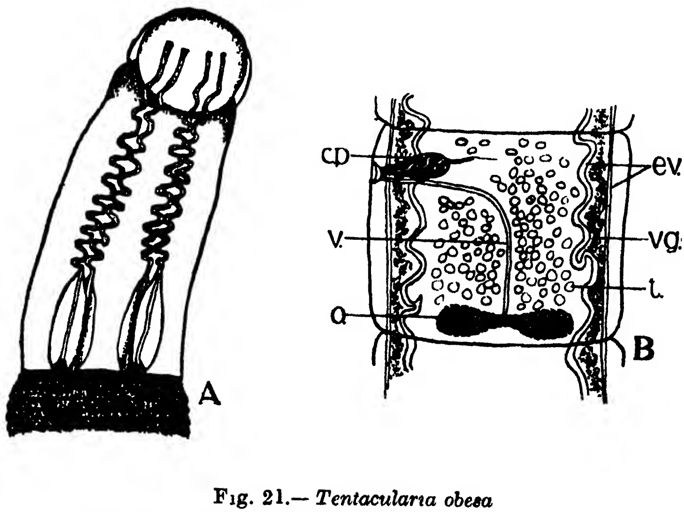


Fig. 21.— *Tentacularia obesa*
A—head and neck × 30. B—mature segment × 33 (Orig.).

The genital pores are irregularly alternate and are situated laterally in the anterior sixth of the segment. The last gravid segment is about 1 mm. square.

Head. The head measures 2 mm. in length and 0·8 mm. in breadth. It is extremely conspicuous because it is semi-transparent, while the rest of the worm is densely opaque, the junction between the two being very pronounced. There are two simple bothridia measuring 0·5 mm. in length and 0·55 mm. in breadth. The proboscis sacs are situated in the posterior quarter of the head close to the first segment. They measure 0·54 mm. in length and 0·16 mm. in breadth. The proboscides were not protruded and hence it is impossible to describe the hooks; but they appeared to be all alike, simple, slender, recurved, and to measure about 12 μ.

Testes and Vas deferens. As only one worm was obtained it is impossible to describe the genital organs in detail. The testes are well developed in the tenth segment, and in the twentieth segment they fill the centre of the proglottis extending posteriorly to the ovary on both sides.

The cirrus pouch is a cylindrical organ situated in the anterior sixth of the segment and extending in the median direction about one-fifth the breadth of the proglottis. No details relating to the cirrus or vas deferens could be made out.

The ovary is small, situated posteriorly, and from it the vagina runs to the pore, in a broad curve, as a very wide conspicuous duct.

The vitelline glands appeared to be limited to the lateral margins. There is a large shell gland posterior to the ovary.

The uterus is a wide sac, entirely filling the segment. The shape and the size of the eggs could not be determined.

This species is characterised by the transparent head and by the short obese strobilus. The head bears a general resemblance to that of *T. johnstonei*, n. sp; it differs from it, however, in size and in the position of the genital pore.

Tentacularia binunca (Linton, 1909). Fig. 22

Rhynchobothrium binuncum, Linton, 1909.

One specimen of this worm was obtained by the author from the intestine of *Dasybatus* sp. (*walga* ?), Ceylon Pearl Banks, 27.11.10.

The species is distinguished by the peculiarly shaped hooks on the proboscides, by the worm being composed of about seven segments—the last being almost as large as the remainder of the worm—and by the pore being situated in the posterior third of the segment.

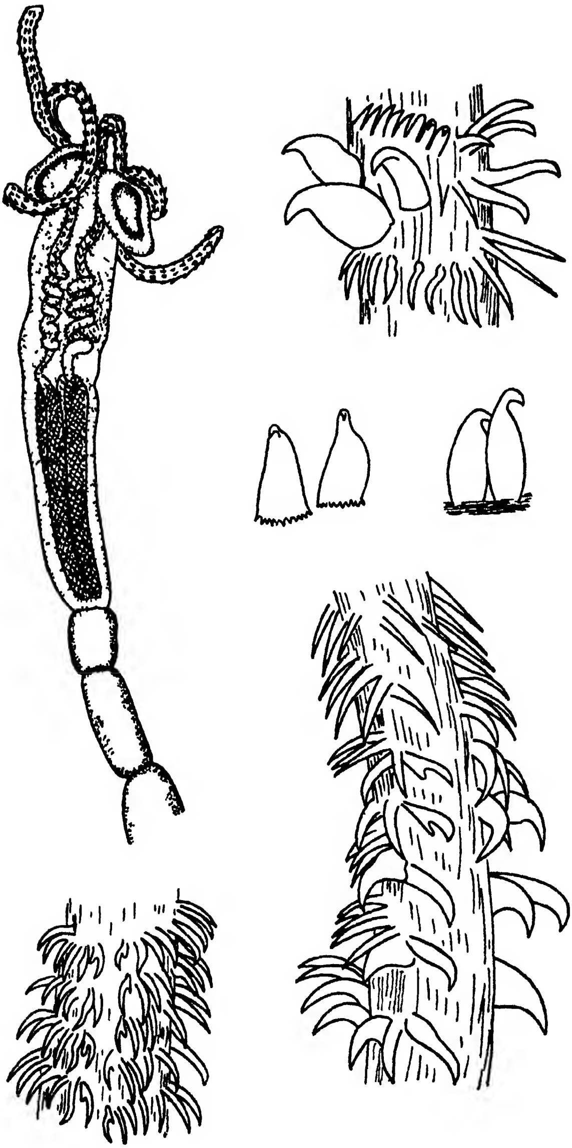


Fig. 22.—*Tentacularia binunca*
Head and proboscis hooks. Magnification unknown. (After Linton).

Tentacularia ilisha (Southwell and Prashad, 1918). Fig. 23

Rhynchobothrius ilisha Southwell and Prashad, 1918.

Bothria two, lateral, entire, rounded, external face hollowed to form a sucking disc; widely separated posteriorly, and approximated anteriorly. Neck shorter than the head, flat. Proboscides filiform and armed with four kinds of hooks, arranged in oblique circles, the larger hooks being distributed principally on the outer surface. Anterior segments shallow and numerous. Last segment much longer than broad. Total number of segments about 232. Genital apertures irregularly alternate, and

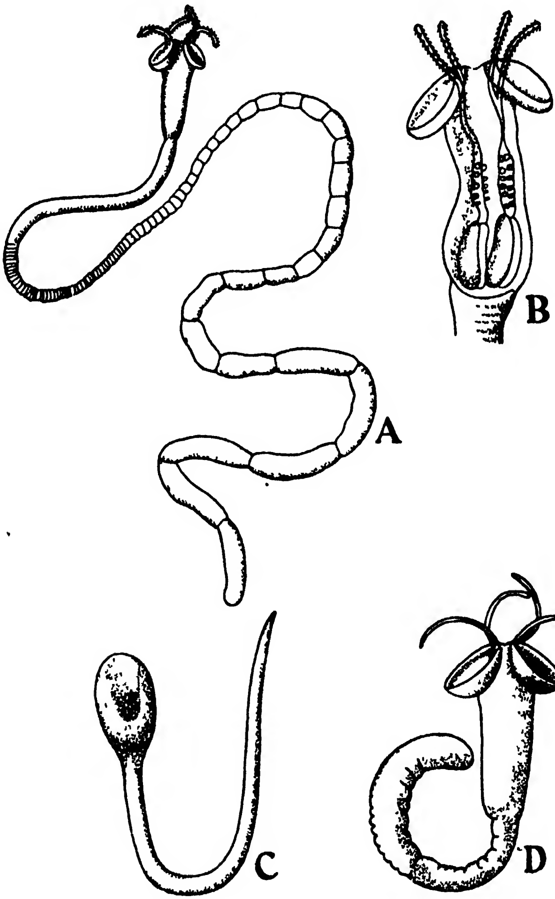


Fig. 23.—*Tentacularia ilisha*

A—entire worm. B—head. C—cyst from muscle of Hilsa. D—young worm from stomach of shark. Magnification unknown. (After Southwell and Prashad).

situated about the posterior third of the proglottid. Length of worm 11·5 cms. Posterior segments separating in two's and three's.

Habitat. The large intestine of *Carcharias gangeticus* (Müll. and Henle). Khulna, district Khulna, Bengal, 21st October, 1917. Eleven adult specimens, several young forms just emerged from the cyst, and three cystic forms. Larval forms in *Clupea ilisha.*

External Anatomy. The head is large compared with the size of the worm and measures 4·2 mm. in length. The breadth of the anterior extremity is 2·6 mm., and of the posterior extremity 1·4 mm. Length of bothridia 1·8 mm. Length of proboscides 2·1 mm. Length of proboscis sacs 1·6 mm.

The bothridia are paired, approximated anteriorly and widely separated posteriorly. They are round in shape, having entire margins, and sucker-like external surfaces. The proboscides are four in number ; the armed portion is very short, with an equal length unarmed and very long tubes connecting them to the proboscis sacs. The hooks are of four types arranged in oblique rings, the larger ones being disposed along the outer margins. As usual, the hooks towards the base of the proboscides are much smaller than the rest.

The neck is short, measuring only 2·2 mm. It is flattened and not cylindrical. The anterior proglottides are shallow and numerous. The posterior proglottides are much longer than broad, measuring 5·1 mm. by 1·3 mm. The male genital organs appear first. The female organs are to be seen only in the last few proglottides. Of the male organs, the testes are first visible about the middle of the worm. The genital aperture is situated about the posterior third of the proglottis, and the male aperture is immediately in front of that of the female.

Internal Anatomy. Nervous system.—This consists of a single fine nerve on each side, external to the water vascular system.

Excretory system. This consists of a single pair of wide tubes, situated one on each side. They communicate with each other by a wide transverse vessel situated at the posterior margin of each segment. In the head they break up into a series of fine vessels.

Testes. These are numerous, occupying the greater part of the mature proglottid. They first appear laterally. From each of these is given off a minute tubule : these unite later to form the vas deferens. This is a thick coiled tube originating a little in front of the ovary and opening directly into the cirrus sac. The vesicula seminalis is a bag-like structure situated close to the junction of the vas deferens and the cirrus sac. The cirrus is fairly long and lies coiled up in the spacious cirrus sac. It is apparently unarmed.

Ovary and Oviduct. The ovary is bilobed. From each lobe a very small oviduct arises. The two oviducts unite in the middle-line and receive, at the point of junction, the duct of the shell-gland. This organ lies between the lobes of the ovary, in the centre line. The uterus originates, anteriorly, from the point of union of the two oviducts. It runs forward in the middle-line as a blind diverticulum, practically to the anterior termination of the proglottid, narrowing as it goes. The vagina also originates close to the mouth of the uterus and is continued as a narrow coiled tube to near its opening. It then widens to form a barrel-shaped receptaculum seminalis.

Life History. A partly digested Hilsa was found in the stomach of a shark by Southwell and Prashad, and all stages in the development of this worm were observed by them. The cysts were tadpole shaped and consisted of a club-like head, and a long tail-like structure which was capable of considerable movement, and appeared to serve the purpose of mooring the larva in the intestine of the shark, during the digestive processes.

The head, in one specimen, measured 4·8 mm. by 3·6 mm. The tail tapers to a point and measured 51·8 mm. in length. On opening out the " head," the larva was seen to be a massive structure occupying the greater part of the head and lying in a coiled position. The tips of the four proboscides were just everted, and the spines could be clearly seen. Many young worms were also obtained from the lumen of the intestine. These had not had time to attach themselves to the intestine of the host.

Tentacularia spiracornuta (Linton, 1907). Fig. 24

Rhynchobothrius spiracornutus Linton, 1907.

Two larvae only ; one from *Caranx* sp. and one from *Thynnus* sp. Pearl Banks, Ceylon. Dr. Pearson.

The total length of the larva, or head, with its attached blastocyst is 9 mm.; the blastocyst measures 3 mm. in length and the larva (head) 6 mm.

The blastocyst has a breadth of 0·5 mm. to 0·6 mm. The breadth of the head across the bothridia is 0·6 mm., across the proboscis sacs 0·47 mm., and across the portion between the sacs and the bothridia the breadth is 0·3 mm.

There are two simple bothridia having a length of 0·63 mm. The proboscis sacs have a length of 0·9 mm., *i.e.* they are between one-sixth and one-seventh the total length of the head,

The hooks on the proboscides are very densely crowded together. On one face of the proboscis the hooks are for the most part long and thin and vary in length from 30 μ to 38 μ. Along one margin of the same surface, however, they are more thorn-shaped, stout, and have a length of 30 μ.

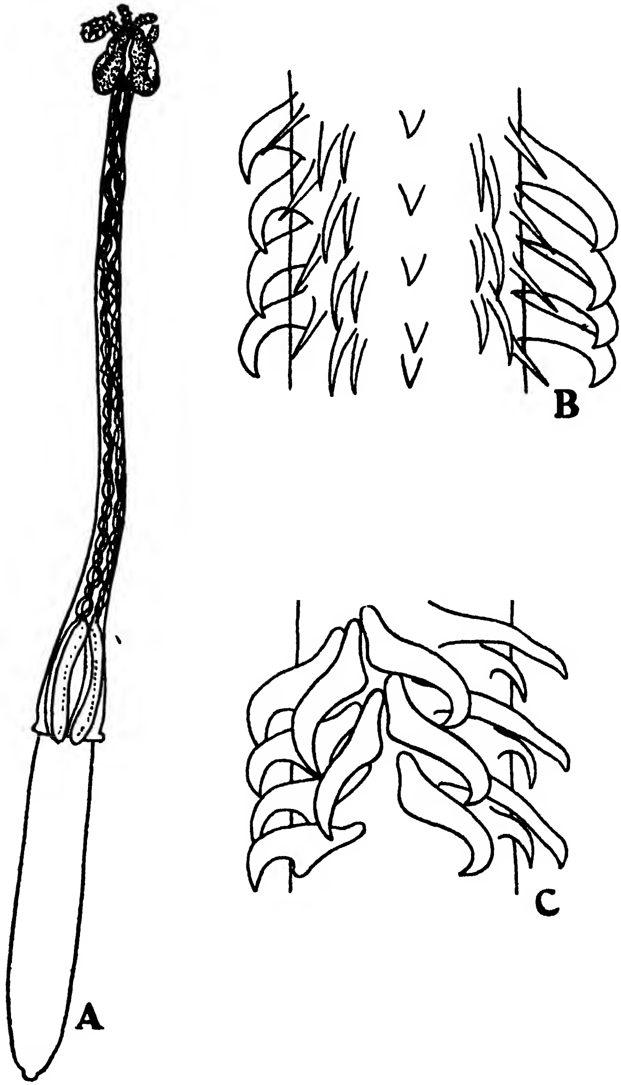


Fig. 24.—*Tentacularia spiracornuta*
A—larva × 18. B.C—proboscis hooks × 500 (Orig.).

On the other surface of the proboscis there are a number of simple curved hooks similar to those on the opposite surface of the proboscis, but measuring only about 20 μ. Marginally these grade into numbers of very small hooks which measure 10 μ only.

The specimens agree closely with Linton's description of this species. He obtained the larva from cysts on the viscera of *Epinephalus maculosus* and *Paranthias furcifer*. The length of the head to the base of the bulbs was 5 mm. The length of many of the hooks was 24 μ. He described the worm as follows :—

> 'Head usually broader than long, orbicular or cordate ; bothria lateral—that is, coinciding with the lateral margins of the body, with raised borders—neck long, slender, nearly linear, enlarging at base, sometimes appearing to begin abruptly by an articulation with the head and usually abruptly larger than the anterior end of the body ; proboscides much shorter than neck, with a tendency to coil up into rather close spirals when everted ; sheaths nearly straight, bulbs long-ovate, retractor muscle attached to posterior end. The hooks are of many different shapes and sizes, but on account of the similarity of the hooks, which make up the several longitudinal rows, the general effect is that of uniformity and symmetry. There is some resemblance in the arrangement of the hooks to that of *R. speciosum*, particularly in the case of one of the longitudinal rows, where the small hooks of which it is composed are placed by twos on account of the lengthening of alternate intervals between the hooks of the row. A characteristic feature of this species is the distinctness of the longitudinal rows of hooks. There was no indication of segments.'

The larva also resembles the head of *T. benedeni* Vaull., 1899, but is very much larger.

Tentacularia pillersi n. sp. Fig. 25

A very large number of larvae from cysts in muscles round vertebral column and especially in haemal arch of *Cossyphus axillaris* caught on two occasions, viz. In Trawl, off Adrianpatnam, India, 7.9.20 (84. XIV. a.) Marine Biological Survey ; and (2) in Trawl, off Delft, India, 7½ fathoms, Marine Biological Survey 22.9.20, Dr. Pearson. In the fish caught at the latter station cysts containing larval forms of *Gymnorhynchus gigas* (=*Syndesmobothrium filicolle*) were found amongst the pyloric caeca and also cysts containing *Tentacularia macfiei*, n. sp. Large numbers of adult unencysted Trematodes were also found between the pyloric caeca and also enormous numbers of immature nematodes, varying in size from 0·5 mm. to 20 mm. Very frequently these nematodes were found adherent to the cysts containing the larvae of *T. pillersi* n. sp. and in practically all such cases the contained cestode larvae had degenerated. The cysts were oval in shape and measured about 12 mm. by 8 mm., although many smaller, and a few larger, were found. They occurred in very large numbers and often about 15 would be situated together, like a small bunch of young grapes.

In a few of the cysts calcification had commenced and no larva was to be found. Other cysts were full of pus and were likewise sterile. Pus formation also occurred in parts of the surrounding tissue. As noted above, many of the cysts on whose walls immature nematodes were found were also sterile.

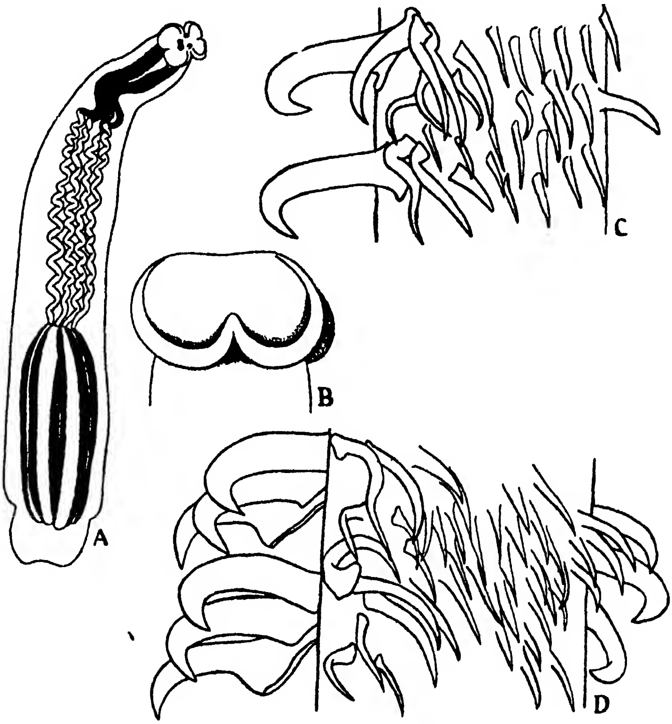


Fig. 25.—*Tentacularia pillersi* n. sp.
A—larva × 7. B—head × 35. C—proboscis hooks × 160. D—proboscis hooks × 215 (Orig.).

The outer cyst has a thin, semi-transparent, but tough wall. It is presumed that this is secreted by the host. The inner cyst wall is very thick and dark-brown measuring about 9 mm. by 5 mm. The larva, to which no blastocyst appeared to be attached is characteristically lancet-shaped, 15 mm. in length, 3 to 3·5 mm. in breadth posteriorly and 0·8 to 1 mm. in breadth anteriorly. There are two very small simple bothridia measuring about 0·7 mm. in length and 0·9 mm. in breadth. Their posterior margins are indented. The proboscis sacs are situated posteriorly and measure 4·5 to 5·5 mm. in length and 0·45 mm. in breadth. The proboscides are very coiled throughout the length of the

head. About 15 larvae were examined. In only one case was a single proboscis everted and then only to a length of 1·5 mm. Consequently, the shape and arrangement of the hooks on the proboscides is not definitely known. The proboscides were dissected out and boiled in caustic soda and it was found that all the hooks had been dissolved. The opportunity is here taken of noting that when the heads of Tetrarhynchids are cleared in pure carbolic acid, the hooks swell out and develop " blisters," so that neither their shape nor arrangement can be determined.

The free portion of the protruded proboscis was examined carefully, but only one view was, of course, to be seen ; three other proboscides were teased out, so that a number of differently shaped hooks were isolated. The hooks did not appear to be spirally arranged. One surface of each proboscis is covered with small simple elongated hooks, varying in size from 65 μ to 130 μ. On one margin there are a cluster of 3 curved hooks measuring 90 μ, and at a deeper focus two larger alternating rose-thorn shaped hooks measuring 130μ can be seen. Along the other margin there are 3 large rose-thorn shaped hooks measuring 130 μ and at a deeper focus two stouter alternating rose-thorn shaped hooks like those on the opposite margin, also measuring 130μ could be seen.

It appears probable that the larva named by Southwell *Rhynchobothrium* sp. II on p. 271, Ceylon Marine Biological Reports and figured on Pl. 11, figs. 29 and 30 is the same species, although smaller. His description was as follows :—

> 'Large numbers of cysts containing larvae of a second species of *Rhynchobothrium* were obtained from the mesenteries of various fishes caught during 1908 to 1911. The cysts when preserved are often globular, and measure 15 mm. in diameter. The outer part of the cyst is sometimes gelatinous in nature, and is usually absent. Inside the gelatinous covering is the cyst proper, which measures 5 mm. by 3 mm., and is either of a milky-white or golden-yellow colour.
>
> 'The larva itself lies bent in two inside this cyst. It measures 5 mm. long and 1·5 mm. broad posteriorly. The posterior part is 3·5 times the breadth across the bothridia, and the sacs measure almost half the length of the head and neck. The proboscides are coiled, and are not protruded to the exterior, their external openings being closed. The spines are of various sizes and shapes, and do not appear to have any definite arrangement. There are two very small, undivided, saucer-like bothridia, having a diameter of barely ·5 mm. There are no strobila.
>
> '*Habitat.*—(i) Walls of the air bladder of *Lutjanus argentimaculatus.* Twelve specimens. November, 1908.
>
> (ii) The mesenteries of *Drepane punctata.* Nine specimens. February 28th, 1911.
>
> (iii) The mesenteries of *Diagramma* sp. Twenty specimens. November, 1910.
>
> (iv) The mesenteries of *Serranus undulosus.* Over one hundred specimens. November, 1910.'

A number of specimens have been obtained from material recently sent by Dr. J. Pearson, *viz.*, (I) from *Serranus* sp. caught off Negapatam, Ceylon Marine Biological Survey 6.9.26, and (II) from *Cossyphus axillaris*. In Trawl, off Adrianpatnam, India, 7.9.20 (84. XIV. a) Ceylon Marine Biological Survey.

The larva from the above fishes is also lancet-shaped and measures 6 mm. in length. Its breadth posteriorly is 1·9 mm. and anteriorly 0·5 mm. The proboscis sacs measure 2 mm. in length. In no case were the proboscides everted. There are two small bothridia each having its posterior margin notched. The appearance of the hooks when the proboscides are teased out resemble those of the bigger larva, and there can be no doubt that the two sizes of larvae represent identical species.

The species can be easily identified on account of its :—

(1) Large size,

(2) Lancet shape,

(3) Large proboscis sacs and small emarginate bothridia,

(4) Its hooks.

No larvae of this shape, and size, has yet been described ; one therefore feels justified in considering the head as new. The commoner Elasmobranch fishes of Ceylon have frequently been examined for cestode parasites and no worm with a head like that described above has been found ; it is therefore probable that the adult worm occurs in one of the large but rarer Elasmobranch fishes.

The species is named in honour of A.W. Noel Pillers, Esq., F.R.C.V.S., in recognition of his practical interest in Helminthology over a period of 20 years.

Tentacularia macfiei n. sp. Fig. 26

The *Rhynchobothrius* spp. I. III. A. B. C. of Southwell, 1912.

Encysted larval forms only have been obtained from the following sources :—

(1) Mesenteries, and sub-mucosa of stomach, of *Cybium guttatum*. Pearl Banks, Ceylon. Numerous specimens on various dates between 1907 and 1911 ; and from same host, Quilon, Travancore. Dr. Pearson, 18.4.23.

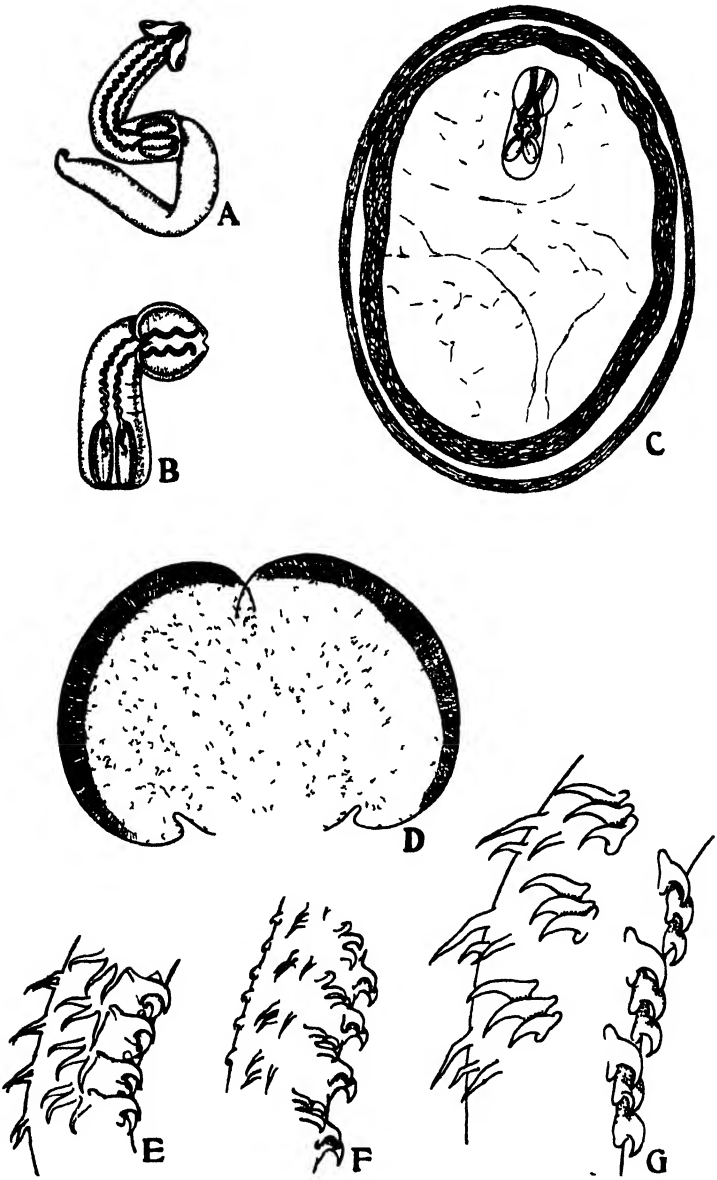


Fig 26. *Tentacularia macfiei* n. sp.

A—larva (= *Rhyncho.* sp 1. Southwell, 1912). B—larva (= *Rhyncho.* sp 3. Southwell, 1912). Magnification unknown (After Southwell) C—cyst × 42. D—a bothridium × 75. E.F—proboscis hooks × 214. G—proboscis hooks × 500 (Orig.).

(2) Muscles around vertebral column of *Cossyphus axillaris.* Off Delft. India. Ceylon Marine Biological Survey. 22.9.20. And again from same host, same locality, 7.9.20. Dr. Pearson.

(3) Pyloric appendages of *Trichiurus savala.* India. Nos. 246 and 247. 22.9.27. Dr. Pearson.

(4) Mesenteries of *Chorinemus lysan* and *C. toloo.* Pearl Banks, Ceylon. 1910.

(5) Pyloric caeca of *Lutjanus argentimaculatus.* Pearl Banks, Ceylon, 1909.

(6) Pyloric caeca of *Serranus stellatus.* Pearl Banks, Ceylon, 1909.

(7) Mesenteries of *Balistes* sp. Pearl Banks, Ceylon, 1908.

It is very probable that one of the larvae figured by Shipley and Hornell, 1906, from *Balistes mitis,* (viz. Pl. II, fig. 27) is the same species.

Southwell described the cysts and larvae in 1912, stating that the cysts measure about 12 mm. by 4 mm. and are milky white in appearance. The larvae measure about 7 mm. by 0·6 mm. The head bears two bothridia, each one emarginated posteriorly. The hooks were stated to be all alike, but such is not the case. It is practically certain that the five larvae described as *Rhynchobothrium* spp. A.B.C. and I and III and figured by Southwell (1912, p. 272, Pl. III, figs. 31, 32, 33, 34 and 35) from *Serranus undulosus, Lutjanus gibbus, Psettodes erumei* and *Balistes mitis,* respectively, are identical with those from *Cybium guttatum.*

Additional material from *Cybium guttatum* has been obtained and examined and the writer is now able to add the following details.

The cysts and the larvae vary considerably in size in different species of fishes and even in one host ; the different sizes merely represent growth stages.

The cysts are semi-transparent, milky white, club-shaped, or oval with broad ends, measuring about 7 mm. by 4 mm. The larva is attached by the extremity of its head to one end of the cyst, and measures up to 5 mm. in length. Its breadth across the proboscis sacs is about 0·8 mm.; its breadth across the bothridia varies and its breadth across the rest of the head is about 0·7 mm. There are two bothridia, each emarginated posteriorly. They have a length of about 0·9 mm. and a breadth of about 0·8 mm. A cluster of cilia runs parallel with the margin of each bothridium arising on each side of the posterior indentation and gradually disappears anteriorly. The proboscis sacs have a length of 1·1 mm., *i.e.,* they are approximately one-quarter the length of the head.

The four proboscides lie very coiled within the head. They are armed with closely set hooks of different shapes and sizes as shewn in fig. 26. Posteriorly the larva carries a blastocyst which varies in length from about 1 mm. to 5 mm.

The appearance and size of the head and the hooks of this worm bear a somewhat close resemblance to an adult worm figured by Linton in 1909 under the name *Rhynchobothrium* sp. He obtained a single specimen only from *Ginglymostoma cirratum*. His description is as follows :—

'Bothria foliaceous, but with margins somewhat thickened ; head much broader than neck ; neck slender, cylindrical, enlarging at bulbs ; sheaths in close spirals ; bulbs long-oval, with retractor muscle attached at about the middle of the length on the median wall ; proboscides long, hooks of different sizes and shapes. The most marked differences are to be seen in those hooks which are near the base of the proboscides. On one side there are some small, straightish spines ; on the other they are much larger, long and nearly straight, but with an abrupt curve at the apex. A single row of these large hooks extends around to the opposite side a short distance from the base. The proboscides were not seen fully extended. So far as seen, the hooks on one side remain small, slender and very sharp-pointed, but grow larger toward the apex, so that in the completely everted proboscis the difference between the hooks of the opposite sides is probably slight. The large hooks with abruptly recurved ends are confined to the basal region. Beyond the base the larger hooks become rather broad, in lateral view, and are strongly and uniformly curved. On the other hand, among the small hooks some distance from the base are hooks which are straightish with abruptly curved tips. Towards the tip of the proboscis, as may be seen in the retracted part, a prevailing form is a slender hook curved in two directions, like a letter S nearly straightened out.

'Transverse striae begin immediately below the neck. The first distinct segments are shorter than broad, but soon become as long as broad. They then rapidly and uniformly lengthen, but remain about the same breadth. The posterior segments are nearly ten times as long as broad, and their anterior ends are abruptly larger than the posterior end of the preceding segment. None of the segments were mature, although rudiments of reproductive organs could be made out. In the next to the last segment the rudiment of the cirrus bulb was a little behind the posterior third, and the ovary was at the posterior fifth. The anatomy of the posterior segments, so far as it could be made out, is much like that of *R. exile*.

'Dimensions, in millimetres, of specimen mounted in balsam : Length 15 ; length of head and neck 2·4 ; breadth of head 0·73 ; bothrium length 0·48, breadth 0·48 ; bulbs, length 0·64, breadth 0·16 ; twentieth and last segment, length 2·08, breadth 0·22 ; proboscis, length, estimated, 3, breadth, exclusive of hooks, base 0·05, near apex 0·04 ; length of longest hooks, base 0·035, at apex of everted part, about 0·6 from base, 0·028. From spiral valve of nurse shark. *Ginglymostoma cirratum*. July 6th, One.'

Although this larval form is very common in various bony fishes on the Ceylon Pearl Banks, the adult has not apparently been found, and as no adult worm with a head and with similar hooks has yet been described, the author considers it to be new and has named it in honour of Dr. J. W. S. Macfie to whom the writer is indebted for large collections of cestodes from the Tropics.

(b) LARVAL FORMS

Tentacularia pinnae (Shipley and Hornell, 1904). Fig. 27

Tetrarhynchus pinnae Shipley and Hornell, 1904.

'The advanced larva or metacestoid is enclosed in a large vesicle, which not only covers the head, but the entire body, and is much larger than the body, 1 millim. to 15 millims. long. The teeth on the introvert are very numerous and arranged in oblique lines. Each tooth is slender, very slightly hooked, and is shaped like a Malay kriss. The proboscis sheaths extend nearly to the posterior end of the scolex. Two lappets.

'Habitat :—The metacestoid larva lives in cysts in the tissues around the alimentary canal of *Balistes stellatus* and *B. mitis*, the younger larvae probably in a *Pinna* sp. from Ceylon.'

(Shipley and Hornell, 1904.)

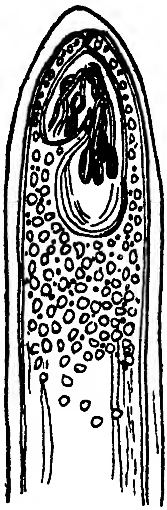


Fig. 27.—*Tentacularia pinnae*
Cyst. Magnification unknown (After Shipley and Hornell)

Genus 2. TETRARHYNCHUS Rudolphi, 1809

Small to medium sized worms ; head with four bothridia lying parallel with the body and having their sucking surfaces facing externally.

Type-species :—*Tetrarhynchus appendiculatus* Rud., 1809.
= *Echinorhynchus quadrirostris* Goeze, 1782.
= *Echinorhynchus conicus* Zeder, 1800.

The adult worm of *T. appendiculatus* is not known. The larval host is *Salmo salar*.

The " *Tetrarhynchus lingualis* " group includes the following species in which (a) the head is produced backwards into a prominent collar[1] which overhangs the anterior part of the strobilus, and (b) the hooks on the proboscides are almost always minute and of equal size, viz. :—

T. lingualis Cuvier, 1817.
T. bisulcatus (Linton, 1889), Linton, 1897.
T. robustus Linton, 1890.
synonym : *T. narinari* MacCallum, 1917.
T. tenue Linton, 1890.
T. equidentatus Shipley and Hornell, 1906.
T. herdmani Shipley and Hornell, 1906.
T. perideraeus Shipley and Hornell, 1906.
T. palliatus Linton, 1924.

(*a*) ADULT FORMS

Tetrarhynchus perideraeus Shipley and Hornell, 1906. Fig. 28

Shipley and Hornell described this species as follows :—

'This species was present in large numbers in the small intestine of *Carcharias gangeticus*. The head and a peculiar extension of the head in this species is a well marked shade of dark grey, which contrasts vividly with the matt-white of the rest of the body. Even in the stained and mounted specimens peculiar coloured granules can be recognised, which doubtless give rise to this colour in the living animals. This is a big species, some specimens attaining a length of 70 mm., possibly more, as the bottle in which they travelled was full of segments. The width varies but is never great, and even the head never exceeds about 1·3 mm. The head bears two lappets, but they are so divided in the centre as to appear as four. They are very compressed into the head, and do not stand out. They appear rather puckered at their edges. The proboscides are slender and bear oblique rows of very minute teeth, all of uniform size. The proboscis tubes and proboscis sheaths are alike short. The head is produced backwards into a very characteristic collar which overhangs and embraces the anterior part of the body. This is a very marked feature. There is a fairly long neck, the first trace of segmentation occurring some way behind the posterior limit of the collar. The proglottides have straight sides, and except at the posterior end there is no sign of the cuticle being indented between them. One peculiarity is that the body, usually about the middle of its length, is thrown into coils and twists of a very characteristic form. In the anterior proglottides one sees a central stained part, possibly the uterus ; posteriorly, however, the scattered testes are visible, and the vas deferens and penis, represented sometimes by a clear area, runs from about the centre of the anterior border of each proglottis to the middle of either side, right or left, irregularly alternating.'

In 1924 Southwell gave a brief description of the anatomy. As more material has now been obtained a full description is now given. Shipley and Hornell's specimens were from *Carcharias gangeticus*. Four specimens from *Ginglymostoma concolor*, Pearl Banks, Ceylon, 30.9.1925, have since been obtained by Dr. Pearson.

1. In one species of the genus *Otobothrium*, namely *O. insigne*, the head also bears a collar, an indication that the artificial distinctions which are made be ween genera cannot be pushed too far.

The worm measures up to 70 mm. in length and 1·7 mm. in breadth. It is composed of a large number of segments with convex margins, all of which are much broader than long. The last gravid segment measured 0·5 mm. in length and 1·7 mm. in breadth. The genital pores are irregularly alternate and are situated sub-ventrally a little in front of the middle of the lateral margin. In this respect it differs from *T. lingualis* Cuv., 1817 and *T. bisulcatus* Linton, 1889. There is no neck.

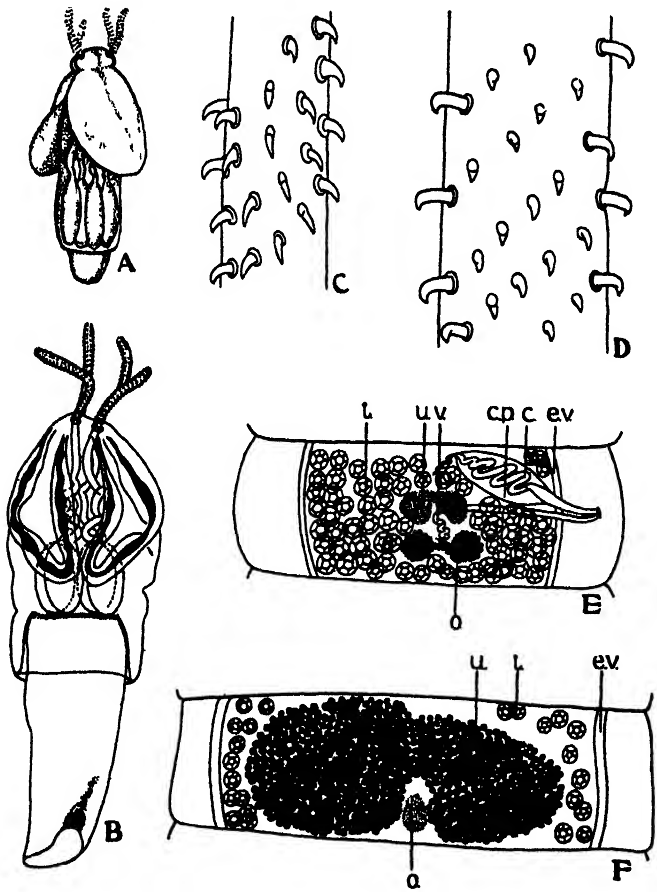


Fig. 28.—*Tetrarhynchus perideraeus*

A—larva. Magnification unknown (After Southwell). B—head and neck × 37. C—proboscis hooks × 330. D—proboscis hooks × 500. E—mature segment × 46. F—gravid segment × 46 (Orig.).

Head. The head measures about 1·3 mm. to 1·75 mm. in length and from 0·8 mm. to 1 mm. in breadth. The four bothridia measure from

0·9 mm. to 1 mm. in length and their posterior extremities lie over the centre of the proboscis sacs. The latter measure 0·35 mm. in length by 0·18 mm. in breadth. The proboscides are short; within the head they form about two coils, whilst their free portions are also short. They are armed with a number of small simple delicate hooks which have their tips slightly recurved, and which measure from 10μ to 12μ. These hooks are arranged spirally, there being 12 hooks in that portion of the spiral which completely encircles the proboscides once, so that 6 hooks are visible in each half spiral. The posterior part of the head is produced into a remarkable fold or collar which encircles the anterior extremity of the strobila.

Testes. The testes vary in number from 60 to 70, they occupy the entire dorsal area within the excretory vessels and a few testes are situated posterior to the ovary

Vas deferens. The cirrus pouch is not conspicuous; it lies anterior to the vagina and median to the excretory vessels; it communicates with the exterior, and opens sub-ventrally by means of a long narrow duct. In the median direction it extends almost half way across the segment, its median extremity being closely apposed to the anterior extremity of the segment; no spines were observed on the cirrus. The vas deferens lies coiled within the cirrus pouch, near the median extremity of which it dilates into a seminal vesicle.

Ovary. This is peculiar in being situated a little distance from the posterior extremity of the segment, and in being small and dumb-bell shaped; it stains very deeply and the two lobes are very compact. The vagina runs posterior to the cirrus pouch.

Vitelline glands. These are very scanty and consist of single acini practically encircling the segment.

Uterus. The rudiments of the uterus consist of an oval organ situated immediately in front of the ovary. Unlike what occurs in most other *Tetrarhynchids* the uterus very early on, forms and consists of, two lateral pouches in communication with each other, which continue to grow until they completely fill the segment.

Eggs. These are oval and measure 34μ by 23μ; the shell does not bear filaments. The writer has found the larval form in *Balistes* sp. Pearl Banks, Ceylon.

Cuvier described *T. lingualis* in 1817; Shipley and Hornell have described three and Linton four other species of *Tetrarhynchids* in which the posterior part of the head is produced into a peculiar fold or collar which overhangs and covers the anterior part of the neck, as in *T. lingualis*; and in all the eight species the hooks are minute and practically equal. The principal points relating to the above nine species are tabulated below.

Tetrarhynchus equidentatus, Shipley and Hornell, 1906. Fig. 29

'This is, I think, the largest *Tetrarhynchus* I have seen, and it is certainly very large to come from the alimentary canal of an Elasmobranch. Unfortunately but one specimen was taken and this measured 4·7 centims. in length, not a very great length; but it is the breadth which gives the magnitude to this animal. It is almost uniformally 3 millims. broad from one end to the other, though it increases very slightly as we pass backwards, but the last proglottis is narrowed. It is perhaps 0·3 millims. thick.

'Compared with the size of the body, the head is very small, and the muscular sheaths come right up to the anterior end of it, and thus there are no more or less coiled tubes between them and the base of the exerted proboscides. The proboscides bear spiral or rather obliquely placed rings of hooks; the hooks are all of precisely equal size and most regularly arranged. They are 0·049 millim. in length. The head bears laterally well marked lappets or bothridia. It is succeeded by an unsegmented region which is about 2 to 2·5 times the size of the head. This region terminates, as in *Tetrarhynchus herdmani,* in a well-marked collar with somewhat scalloped edge. The collar hangs back and overlaps the body region.

'The divisions between the proglottides are anteriorly very insignificant, but they soon become distinct and the proglottides become a little longer. The total number is between one and two hundred. But they are never very long, never even square. The posterior proglottides are always some six or seven times as long as they are broad, and the anterior perhaps twice as much again. Their edges are rounded, there is no trace of overlapping, and in the latter half of the body the reproductive organs cause an opaque patch in each segment.'

(Shipley and Hornell, 1906). From *Trygon walga.*

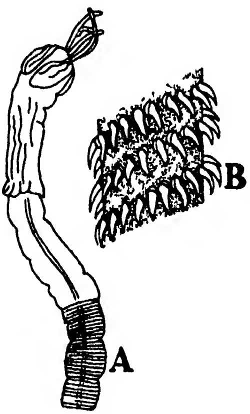


Fig. 29.—*Tetrarhynchus equidentatus*
A—head and neck × 4. B—proboscis hooks × 50. (After Shipley and Hornell).

Poche (1926) as a result of Shipley's and Hornell's statement that the proboscis sacs extend to the anterior extremity of the head, has separated this species from the group and made it the type of a new genus which he names *Acoleorhynchus.* Pintner (1928) figures the proboscis sacs situated almost posteriorly and rightly retains the species in the genus *Tetrarhynchus.*
Shipley and Hornell figure the species as possessing two bothridia.

Tetrarhynchus herdmani, Shipley and Hornell, 1906. Fig. 30

'The second species to [*sic*] *Tetrarhynchus*, found in the alimentary canal of *Trygon walga*, and later in the same position in *Rhynchobatus djeddensis*, is a long and comparatively slender one. We had only three or four specimens, which averaged only about 30 millims. in length. The head is small, only about 1 millim. in length. It has two well developed lappets which, as usual, are very contractable and extensile. The four proboscides emerge from very short muscular sheaths, which lie near the posterior limit of the head. Instead of being half as long as the head, as is often the case in the *Tetrarhynchidae*, they are perhaps from one-twelfth to one-tenth the head length. The proboscides which emerge from them are slender and covered with minute teeth, all of the same size, arranged in spiral rows. The teeth are about 0·01 millim. in length.

'The most characteristic feature of this cestode, but one which it shares with *T. equidentatus*, . . . is a peculiar fold or collar which hangs back from the head and covers the anterior part of the neck. This collar seems to be very extensile. In the figure drawn from the live specimen, its border of free edge is scalloped, but in the specimens in spirit the collar seems more retracted and the free edge is smooth and undivided.

'The neck is very short. Almost immediately after the head the proglottides are indicated by sharp lines. There are some 80 to 100 proglottides present, all separated from one another by clear, horizontal, and in no case concave, lines. Till the proglottides become packed with eggs, the lateral contours are also straight and parallel; there is no overlapping. Thus the cestode does not increase in width until we get to the posterior proglottides, and in these the presence of eggs entails a slight lateral swelling, so that this end is almost moniliform. The eggs are about 0·07 millim. in length.

'In the centre of each of the last half-dozen proglottides is a large clear place. This may possibly be the remains of the genital atrium, and if so, this is median.

'*Tetrarhynchus herdmani* is characterised by having a small head, well-developed bothridia, short muscular proboscis sheaths, one-tenth to one-twelfth the length of the head, teeth on proboscis, uniform in spiral lines, 0·01 millim. in length, well-developed collar, 60 to 100 proglottides, most with parallel sides.

'Habitat :—Stomach of *Trygon walga* and *Rhynchobatus djeddensis*, Mull, and Henle.' (Shipley and Hornell, 1906)

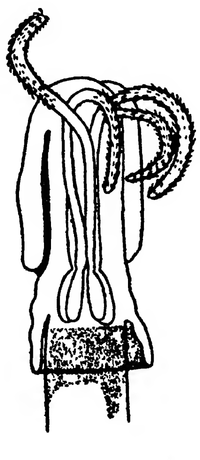


Fig. 30.—*Tetrarhynchus herdmani*
Head × 60. (After Shipley and Hornell).

TABLE SHEWING THE PRINCIPLE CHARACTERS OF THE EIGHT SPECIES FORMING THE "*lingualis*" GROUP :—

	T. lingualis.	*T. perideraeus.*	*T. bisulcatus.*	*T. herdmani.*	*T. equidentatus*	*T. robustus.*	*T. tenue.*	*T. palliatus.*
Length of Worm	80–100 mm	70 mm	40 mm–230 mm	30 mm	47 mm × 3 mm	20–24 mm	13–20 mm	30 mm
No. of Segments	numerous	very numerous	very numerous	80–100	100–200	?	About 55 figured	many
Position of genital pore	Posterior	a little in front of middle	near anterior margin	middle	?	Anterior	a little in front of middle	middle
Hooks	minute	10 μ	all alike	about 10 μ	49 μ	11μ–14 μ	5 μ	20 μ nearly uniform recurved
Proboscis sacs	egg-shaped overhung by bothridia	$\frac{1}{3}$ length of head short oval in centre of head.	short in centre of head	short $\frac{1}{10}$-$\frac{1}{12}$ length of head Posterior.	long, extending anterior extremity of head	short $\frac{1}{3}$–$\frac{1}{4}$th length of head	$\frac{1}{3}$rd length of bothridia	egg-shaped $\frac{1}{5}$–$\frac{1}{4}$th length of head anterior to middle
Bothridia	4	4	4	2	4	4	4	4

Tetrarhynchus minimus, von Linstow. 1904. Fig. 31

'Length 3·7 millims., the last proglottis measures 1·6 millims. in length and 9·39 millims. in breadth. The body consists of about six proglottides. The scolex or head bears on its anterior third four roundish projections directed backwards; these are the proboscis sheaths from which the proboscides are protruded. The projections bear very minute, closely packed hooks, from their apices the proboscides protrude, and these bear larger hooks at wider intervals. There is a regular gradation in the size of the proboscis hooks. The part of the proboscis which is retracted is arranged in a wavy fashion. The reproductive pore is lateral on the posterior third of each proglottis, but for the most part only immature proglottides were present. The ova are thin-shelled, spherical, with a diametor of 0·039 millim. This is the smallest of all species of *Tetrarhynchus*. Habitat :—the folds of the spiral valve of the intestine of *Taeniura melanospilos*, Blkr., taken off Ceylon, at Trincomaleo.'

(Linstow).

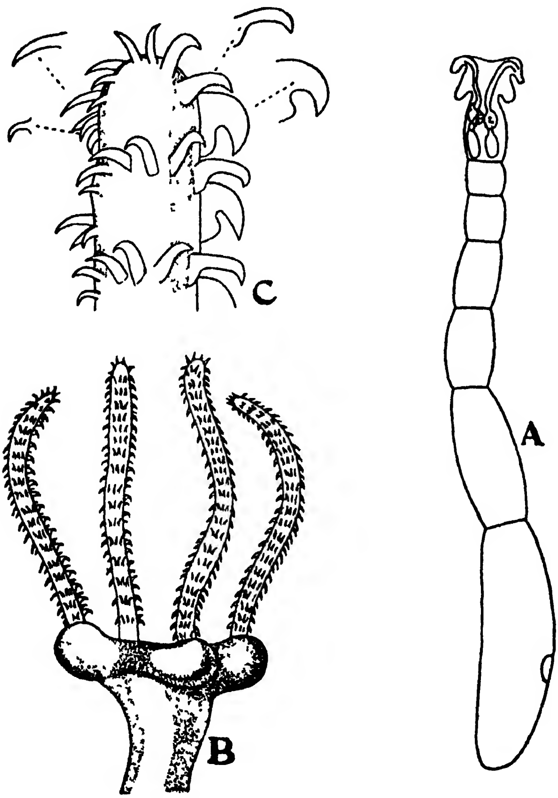


Fig. 31,—*Tetrarhynchus minimus*

A—entire worm. B—head. C—proboscis hooks. Magnification unknown. (After Shipley and Hornell).

The appearance and position of the bothridia, and the form and disposition of the hooks on the proboscides leads the writer to believe that this species belongs to the genus *Gymnorhynchus* (*gigas* ?)

Tetrarhynchus shipleyi n. sp. Fig. 32

About 10 specimens from the intestines of *Ginglymostoma concolor*. The Nursery, Silavaturai; Pearl Banks, Ceylon. April 27th, 1909. T. S.

The worms are very delicate and thread-like ; the largest measured 2 cms. in length, 0·8 mm. in breadth and contained 34 segments ; most of the specimens, however, measured about 1 cm. in length by 0·3 mm. in breadth. None of the specimens were fully gravid. In the most mature worms the testes were developed and the rudiments of the ovary could be seen The last segment measured about 1·45 mm. in length and 0·35 mm. in breadth. The genital pore is situated laterally in the posterior fourth of the segment. There is a comparatively long neck.

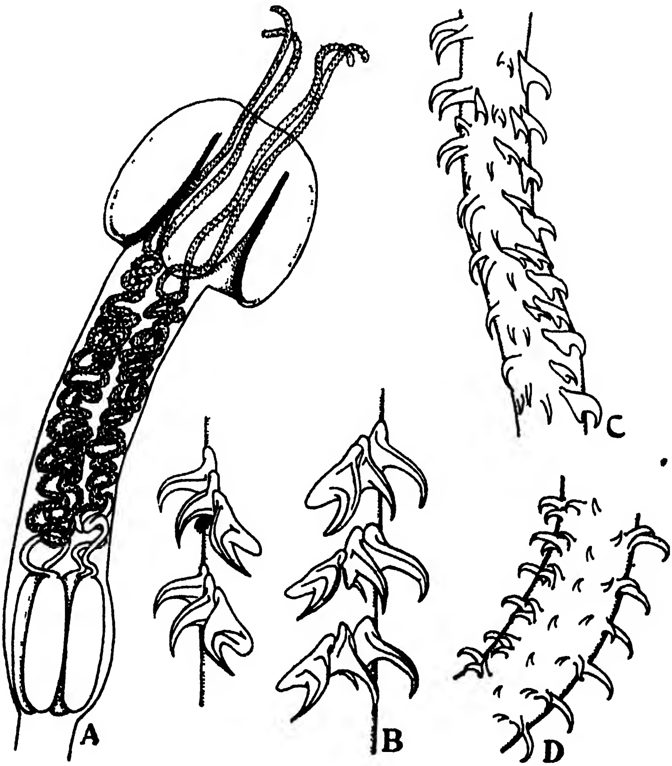


Fig. 32.—*Tetrarhynchus shipleyi*
A—head and neck × 35. B—proboscis hooks × 175. C.D—proboscis hooks × 300 (Orig.).

Head. The head varied in length from 2 mm. to 3·5 mm. In the latter the breadth across the proboscis sacs was 0·48 mm., and the breadth anterior to the sacs was 320μ. The breadth across the bothridia varies according to whether the bothridia are viewed dorso-ventrally or laterally: in the largest specimens the breadth was 0·72 mm. There are four bothridia having a length of about 0·75 mm. They have slightly thickened margins which bears numerous minute cilia; in low power magnification they can be seen as a dark line running parallel to the margin of the bothridia. Evidentally they are deciduous, for in one head both the hooks on the proboscides and the cilia were missing.

The proboscis sacs are short and stout measuring about 0·54 mm. in length and 0·145 mm. in breadth. The proboscides are very long and coiled within the head, and their free portion is also very long. The hooks are all delicate and of various shapes and sizes as shewn in fig. 32, the largest measured about 25μ and the smallest about 5μ. That portion of the head between the bothridia and the proboscis sacs measured 2 mm.

Testes and Vas deferens. The testes are very numerous and fill the entire central field, being densely crowded together. In distribution they present one striking peculiarity in that they extend posterior to the ovary. The cirrus pouch extends 2/5 the breadth of the segment.

The rudiments of the ovary are situated a little distance from the posterior margin of the segment and, as noted above, a number of testes lie posterior to the ovary. No further anatomical details regarding the genitalia could be made out on account of immaturity.

The species is named in honour of the late Sir Arthur Shipley, G.B.E., F.R.S., whose work on the cestodes of the marine fishes of Ceylon induced the writer over twenty years ago to take up the study of these parasites.

Tetrarhynchus ceylonicus n. sp. Fig. 33

Two immature specimens from the spiral valve of *Ginglymostoma concolor*. Silavaturai, Pearl Banks, Ceylon, 1910.

External Anatomy. The parasites have a length of 15 mm. and the greatest breadth is 0·9 mm. There is a long neck 4 mm. in length. The first segments have a length of over 100μ and they rapidly elongate, the last, and posterior segment having a length of 1·8 mm. It was impossible to count the number of segments exactly, but there were about 14. Rudiments of the very numerous testes could be clearly seen in the last 4 segments. The genital pore is situated in the posterior lateral half of the segment. The four excretory vessels were prominent.

Head. The head measures 4 mm. in length. Its breadth across the sacs is 0·77 mm., across the bothridia 0·9 mm., whilst between the sacs and the bothridia the breadth is 0·68 mm. The proboscis sacs measure 1·08 mm. in length and the breadth of each sac is 0·2 mm. The sacs are thus roughly 1/4 the length of the head.

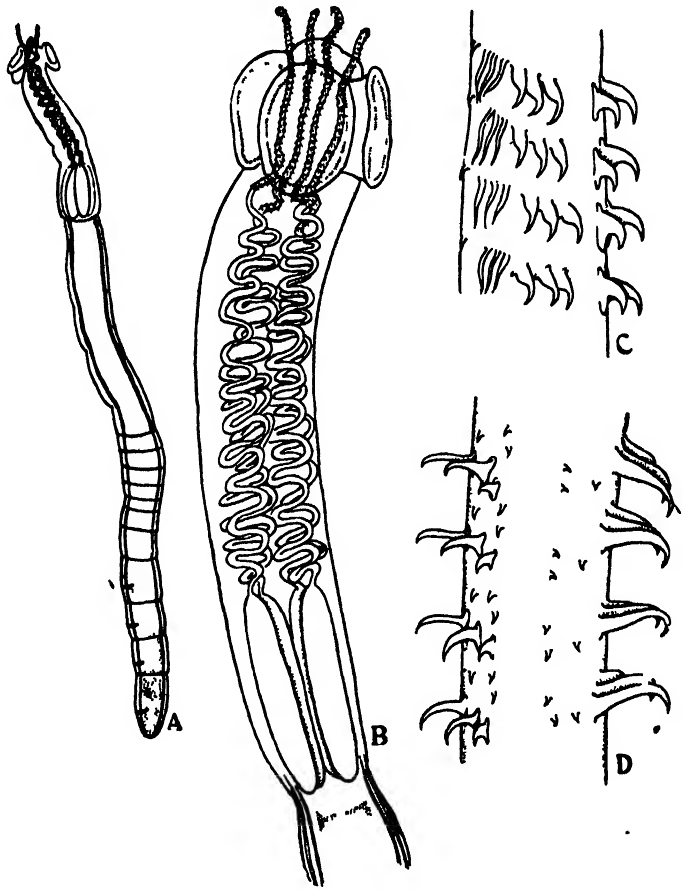


Fig. 33.—*Tetrarhynchus ceylonicus*
A—entire worm × 9. B—head and neck × 30. C.D—proboscis hooks × 400 (Orig.).

There are four bothridia each having a length of 0·63 mm. and an approximate breadth of 0·36 mm. Rows of cilia 13µ in length run parallel to, and at a distance of 18µ from, the margin of each bothridium,

Within the head the proboscis tubes are very coiled and the free portions of the proboscides are short. The hooks are spirally arranged and are generally large and gross. Their arrangement on the two surfaces of the proboscides is shewn in fig. 33. The largest hooks measured about 30µ and the smallest about 3µ in length.

Tetrarhynchus matheri n.sp. Fig. 34

Twelve specimens from the gut of *Ginglymostoma concolor*, Pearl Banks, Ceylon, April 1910. Unfortunately in every specimen all the hooks had disappeared from the proboscides. The specimens were almost mature, but not gravid, and a brief account is here given of the anatomy.

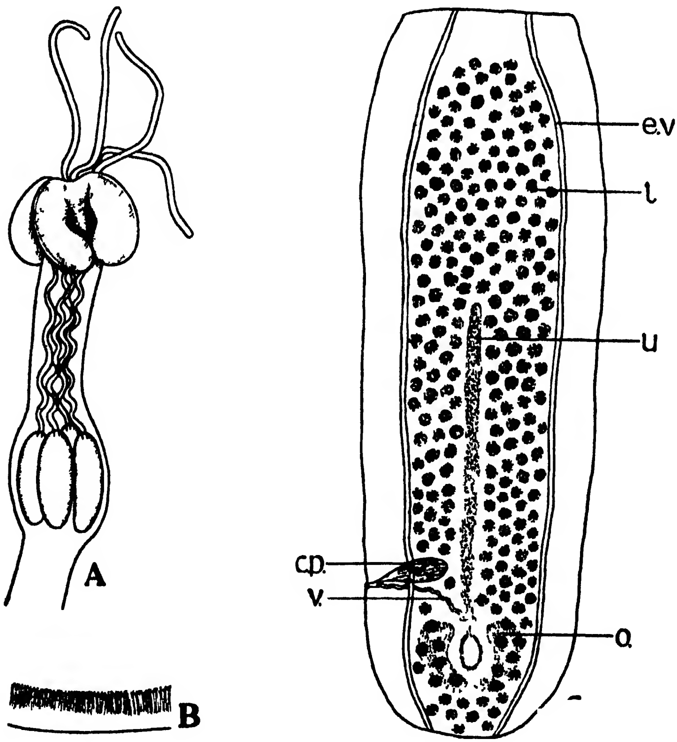


Fig. 34.—*Tetrarhynchus matheri* n. sp.
A—head and neck × 46. B—margin of bothridium showing cilia × 400. C—mature segment × 96 (Orig.).

The worms measure up to 15 mm. in length and the greatest breadth is 0·5 mm. They are composed of about forty segments with perfectly straight margins, the last one measuring 1 mm. in length, and 0·5 mm. in breadth. The genital pores are irregularly alternate, and are situated in the posterior fifth of the worm. The neck is very short, measuring only 0·16 mm. in length.

Head. The head measures about 2·4 mm. in length. The breadth across the bothridia varies according to their state of contraction, but the average breadth is about 0·75 mm. The breadth of the head in the vicinity of the bulbs is 0·44 mm., whilst between the bulbs and the bothridia the breadth is 0·25 mm. There appears to be four bothridia having a length of 0·6 mm. and a breadth of about 0·24 mm.; it is quite possible, however, that there are only two bothridia, each one being almost completely divided into two with a space between the two halves, as in *Tetrarhynchus perideraeus*. Their margins are slightly thickened; a group of cilia run parallel to the margin at a distance of about 15μ. The breadth of the ciliated area is about 5μ, and the cilia themselves measure only 1 or 2μ.

The proboscis sacs have a length of 0·55 mm. and a breadth of 0·14 mm.; there is no collar.

The nervous, muscular and excretory systems were not investigated, but the two longitudinal excretory vessels on each side were prominent.

Testes and Vas deferens. The twentieth segment is about square (0·24 mm)., but the testes are not to be seen until the segment becomes much longer than broad. They are very numerous and occupy the entire central field between the excretory vessels. They extend posterior to the ovary on both sides. They have a diameter of about 40μ. The cirrus pouch and vas deferens were not fully developed. The former extends nearly to the middle of the segment and the excretory vessel is bent deeply in the vicinity of the pouch.

Ovary. The ovary is situated a little distance from the posterior extremity, and the testes overlie the ovary dorsally and extend posterior to it. No details relating to the oviduct, shell gland, or vitelline glands could be ascertained. The uterus was not developed.

The species can be identified by its small size, the position of the genital pore, and by the peculiar appearance of the bothridia.

The type is in the collection of the Liverpool School of Tropical Medicine.

Tetrarhynchus sp. (? **matheri**). Fig. 35

Numerous larval forms with the bothridia exactly like those of *T. matheri* n.sp. were obtained from the mesenteries of *Balistes* sp., Pearl Banks, Ceylon, 1910,

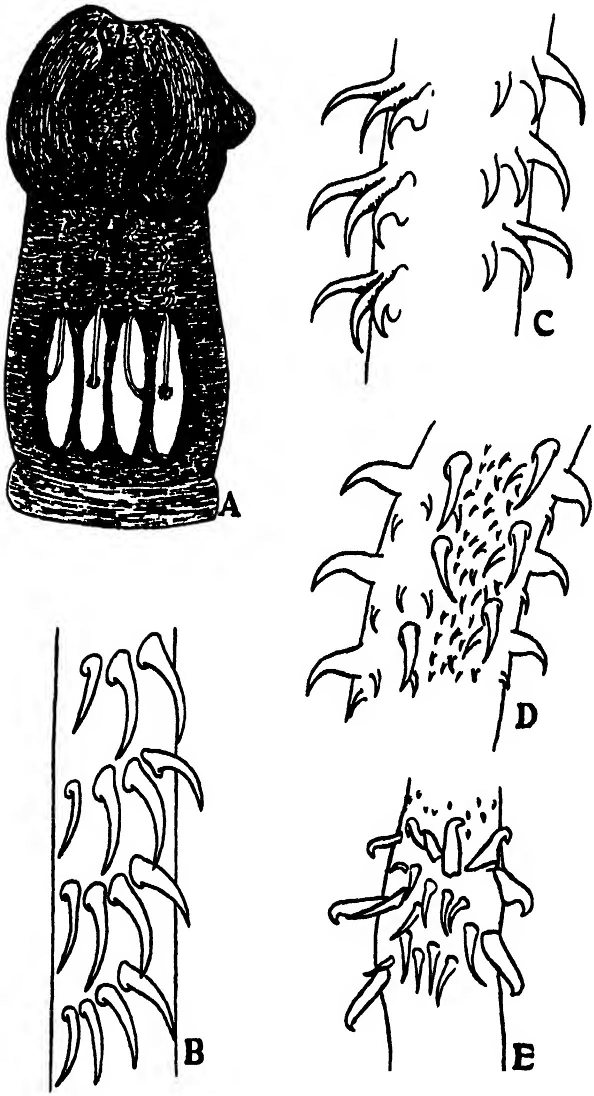


Fig. 35.—*Tetrarhynchus* sp. (? *matheri*)

A—larva × 55. B.C.D—proboscis hooks × 500. E—proboscis hooks × 400 (Orig.)

This larval head differed from the head of *T. matheri* in being about half the length and twice the breadth. The proboscis sacs and bothridia were, however, of the same size as those of *T. matheri*. The only difference appeared to be that the larval head was contracted, while the head of the adult worm was elongated. It was impossible to resist the conclusion that the two heads belonged to the same species of worm.

The cysts varied in size; they are cylindrical in shape with rounded extremities, and milky white in appearance. The largest cyst measured 20 mm. by 1·5 mm. The larva measures 1·7 mm. in length and has a maximum breadth of 0·5 mm. There are four bothridia exactly similar to those figured for the adult of *T. matheri*. The proboscis sacs have a length of from 0·5 mm. to 0·54 mm. and the proboscides were fixed near the middle of the proboscis sacs. The larva does not bear a blastocyst posteriorly.

In one specimen the proboscides were everted. Each proboscis is slightly swollen at its base and bears hooks of different shapes from those found over the rest of the proboscides, and many of them are stouter. Moreover, they do not appear to be arranged spirally.

On this basal portion the hooks on one face are straight, slender, with their points slightly enlarged and they vary in size from 6 μ to 17 μ. Laterally, these are flanked with larger and stouter hooks 30 μ in length, some of which are curved and gradually come to a point, whilst others are stout and have the same diameter throughout, except the tip which is sharply bent at an angle of almost 180°. On the other side of the swollen base of the proboscis there are two longitudinal rows of stout hooks with broad bases rose–thorn shaped with a rather long hook, which measure 43μ.

The hooks on the rest of the proboscis are arranged in such a manner that a diagnosis of the species is comparatively easy. On one face the larger hooks, which are curved, are arranged spirally and there are two or three such hooks in each spiral. They each measure 20μ. Between these spirals there are irregular numbers of hooks, all small, and of sizes varying from about 5μ to 11μ arranged irregularly and reminding one of similar hooks in *T. erinaceus*. These irregularly disposed small hooks are a continuation of those situated on one face of the swollen base of the proboscis, and they change in numbers, size and arrangement along the length of the proboscis. On the other face of the proboscis the hooks are large, spirally arranged, curved, measuring from about 20μ to 25μ, and similar to the 2 or 3 large ones, also arranged spirally, on the other face of each proboscis.

Tetrarhynchus pearsoni n.sp. Fig. 36

As a general principle it is without doubt unwise to describe a new species from a larval worm. In the present instance the form and size of the hooks on the proboscides are so distinctive as—in the opinion of the writer—to warrant the erection of a new species. The larva in question is from the mesenteries of *Cybium guttatum*, Pearl Banks, Ceylon, 1910, and Puri Orissa, India, 1912. The entire larva consists of a head only to which no vesicle is attached. It measures from 2·8 to 3·2 mm. in length and its breadth across the bothridia is 0·72 mm., the breadth across the remainder of the head being about 0·5 mm. There are four sucker-like bothridia, each having a diameter of 0·36 mm. The proboscis sacs are practically half the length of the head. Within the head, the proboscides are very coiled. They are armed with very distinctive hooks of various shapes and sizes, arranged spirally.

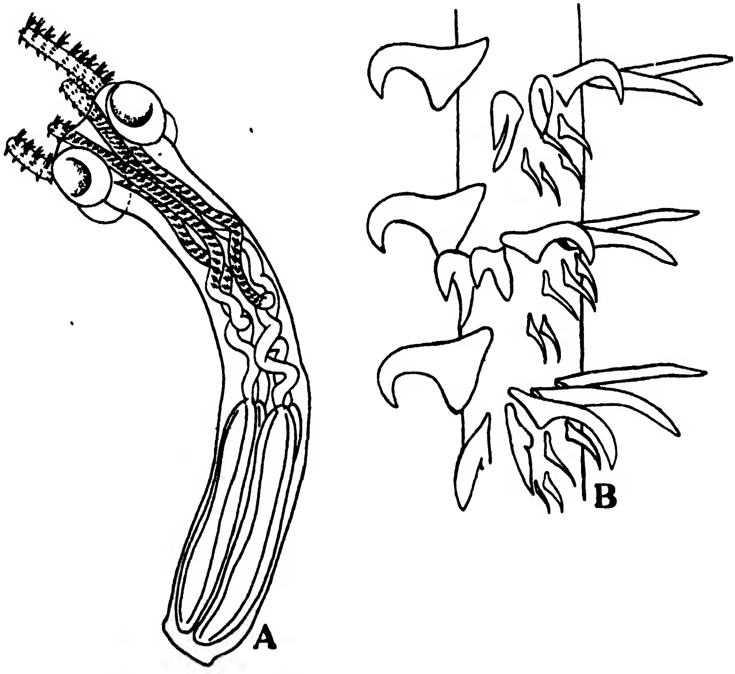


Fig. 36.—*Tetrarhynchus pearsoni* n. sp.
A—larva × 27. B—proboscis hooks × 214 (Orig.).

The upper surface (dorsal ?) of each proboscis bears 6 large hooks in each spiral; a single large rose-thorn shaped hook is situated along the lateral margin. It has a length of 86μ and a broad base measuring 64μ. The succeeding hooks in each spiral become less and less rose-thorn shaped, and more and more sabre-like, until the hooks along the opposite margin are very elongated, sabre-like, with small roots, having a length of 105μ. Between these elongated hooks in each spiral (*i.e.* along the opposite margin of the proboscides to that bearing the gross rose-thorn shaped hooks) there are clusters of regularly arranged minute delicate hooks varying in size from 6μ to 26μ (fig. 35). These minute hooks are continued on the other side (ventral ?) of each of the proboscides, whilst on the lateral margin beneath (ventral ?) the rose-thorn shaped hooks there are 2 or 3 other large spines.

The head bears a general resemblance to that figured by Shipley and Hornell as *T. rubromaculatus* (Diesing), but the hooks on the proboscides differ. In Shipley and Hornell's figures no rose-thorn shaped spines are indicated and the number of small spines shewn by these authors are too few. The hooks resemble strongly those of *T. erinaceus*, but in *T. pearsoni* there are four cup-shaped proboscides, whilst in *T. erinaceus* there are two large flap-like proboscides.

The species is named in honour of Dr. Joseph Pearson, D.Sc., F.R.S.E., Director of the Museum, Colombo, to whom the writer is indebted for the presentation of much material.

(*b*) LARVAL FORMS

(1). **Tetrarhynchus balistidis** Shipley and Hornell, 1904. Fig 37

'Well advanced metacestoid larva, still retaining the body, 12 millims. to 13 millims. in length. Head triangular, enveloped by a closely wrapping vesicle which leaves the body free. Body crowded with calcareous corpuscles. Teeth of introvert few, only 4 or 6 in a transverse row, strongly hooked. Introvert sheathes confined to the head and not entering the body, which, it seems, is after a certain time thrown off with the vesicle. Apparently 4 lappets. In sub-peritoneal tissue'.

(Shipley and Hornell, 1904).

Pearl Banks, Ceylon.

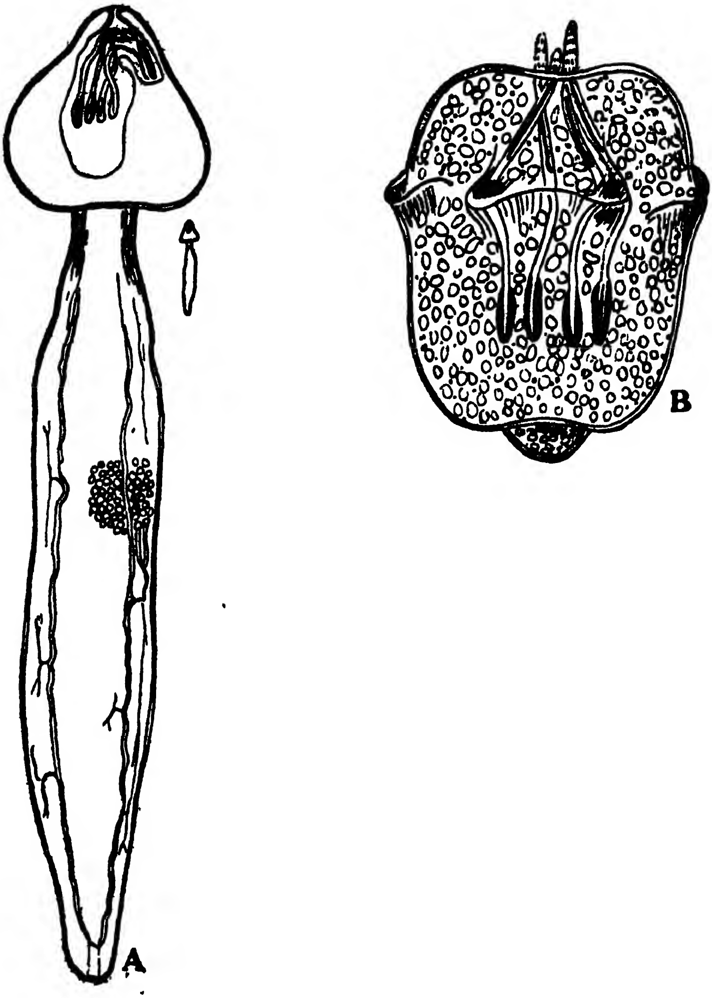


Fig. 37.—*Tetrarhynchus balistides*
A—cyst × about 10. B—larva × 12. (After Shipley and Hornell).

(2). **Tetrarhynchus** sp. Shipley and Hornell, 1906. Fig. 38

'Like *T balistidis*, and consists of a head which has not yet begun to bud off proglottides. The anterior part of the head bearing the lappets is just about as long as the part bearing the proboscis sacs, whilst the median portion traversed by the proboscis sheaths is two or three times as long as either. The proboscis teeth are graded in each row from long narrow, sabre-like outlines to short beaked forms. From the account drawn up at the time of capture from the living material this form had evidently only just escaped from a cyst of the *T. erinaceus* type.'

(Shipley and Hornell), 1906).

It is impossible to identify this larva.

Pearl Banks, Ceylon.

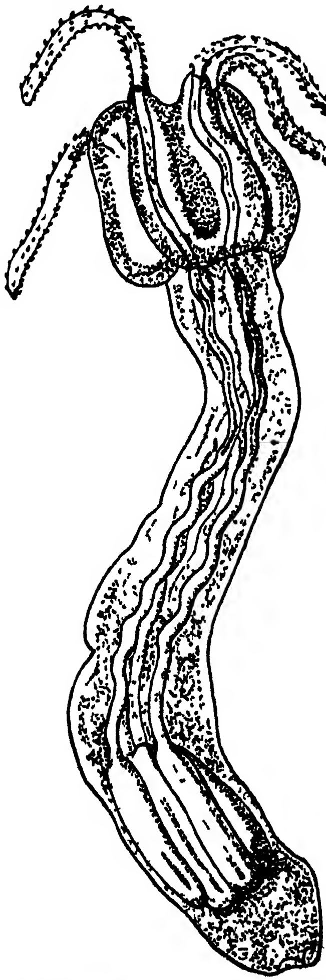


Fig. 38.—*Tetrarhynchus* sp. × 40. (After Shipley and Hornell).

(3). **Tetrarhynchus** sp. Shipley and Hornell, 1906. Fig. 39

'A very different form of *Tetrarhynchus* larva was also taken. Here there is no enveloping bladder, but the Tetrarhynchid head is attached and protrudes from a vesicle which shows signs of an excretory pore posteriorly. This larva is evidently one of Vaullegeard's first division, of which *T. lingualis* is the type. The larva differs from the form we described, under the name of *Tetrarhynchus balistidis*, inasmuch as there is the large vesicle present. The whole length of the larva and head is just under a millimetre. The teeth, as drawn from living specimens, are shown in Plate II, fig. 27a. The wall of the vesicle, seen under a high power, seems to contain a large number of globules, possibly calcareous bodies.'

(Shipley and Hornell, 1906.)

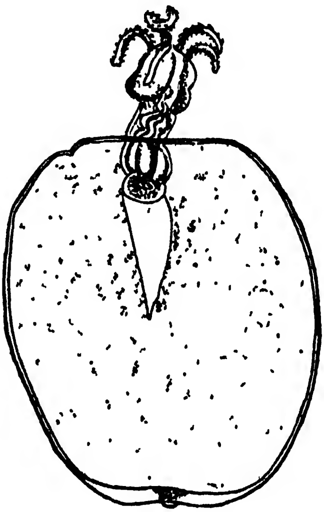


Fig. 39.—*Tetrarhynchus* sp. (? *macfiei* n. sp.) × 75. (After Shipley and Hornell).

This is probably *Tentacularia macfiei*, n.sp.

Pearl Banks, Ceylon.

The adults of the above three larvae have not hitherto been identified.

(4). Southwell (1912) described another larval form as follows :—

'The cysts are long, cylindrical, firm, and opaque. They measure 14 mm. by 2 mm. The larvae measure 2 mm. by 0·6 mm. The bothridia are circular in outline, concave, with thickened overhanging rims, and are indented anteriorly and posteriorly, and each bothridium is divided into two halves by a shallow ridge running parallel to the body. They measure one-third the length of the head and neck. The proboscis sacs also measure about one-third the length of the head and neck. The proboscides are spirally coiled, and do not protrude to the exterior, the pores being closed. The spines are of various sizes and shapes. Some have narrow bases, and are long and slender, with the extremity bent at right angles. Others are short with a broad base, and are strongly recurved. The arrangement of the hooks could not be ascertained.

Habitat—The mesenteries of *Balistes mitis*. Twenty-seven specimens. November, 1910.'

This species has been named *T macfiei*, n. sp.

Pearl Banks, Ceylon.

Dr. Pearson has recently obtained more material from *Balistes mitis*, Ceylon, 30.1.23, and the following larval forms from cysts in the mesenteries have been identified from this host :—

(5.) **Tetrarhynchus perideraeus** Shipley and Hornell, 1906

The cysts are semi-transparent, oval, with broad extremities and flattened, measuring about 6 mm. by 4 mm. The larval head measured 1·3 mm. in length.

(6). ? **Tetrarhynchus rhynchobatidis** Shipley and Hornell, 1906.

The cyst has the form and appearance of that containing *O. dipsacum*, but it differs from it in the following points :—

(*a*). The colour is light brown and the outer cyst wall is stout but very friable, with a mosaic of rounded light brown markings.

(*b*). The larvae is attached to the side of the cyst near the middle.

The larval head is very large, measuring 5 mm. in length, and the two bothridia each measure 1·5 mm. A line of cilia runs parallel with their margins, but disappears anteriorly. The writer has not seen the adult worm. In the larval form the proboscides were not protruded ; the characteristic feature of this worm is the fact that on each proboscis there is a longitudinal row of hooks whose points are reversed and look towards the tip and this could be seen even in the invaginated proboscides.

Genus 3. GYMNORHYNCHUS Rudolphi, 1819

Anthocephalus Bremser, 1824 and Wagener, 1854.
Pterobothrium Diesing, 1850.
Synbothrium Diesing, 1850.
Acanthorhynchus Diesing, 1850.
Syndesmobothrium Diesing, 1855.

Type species *Gymnorhynchus gigas*, (Cuv., 1817)

Bosc in 1797 erected the genus *Tentacularia* to accommodate a larval Tetrarhynchid which he obtained from the liver of *Coryphaena hippurus*.

Cuvier (1817) established the genus *Floriceps* to include certain encysted larval forms of the same group; he also gave the name *Scolex gigas* to a species obtained from *Sparus raji*.

Rudolphi (1819) gave the generic name *Gymnorhynchus* to similar larvæ in which the "body is continuously flattened and tapering, *very long, with a sub-globular vesicle in the neck.* With two bipartate bothridia. Proboscides four, retractile, nude." He placed *G. reptans* Rudolphi 1819 in this genus, giving *Scolex gigas* Cuvier 1817 as a synonym of *G. reptans*. It has since been shown repeatedly that the proboscides are not nude. It is also true that there is not always a vesicle in the neck.

Bremser (1824), as pointed out by Creplin, Dujardin and Vaullegeard, gave a figure of Rudolphi's *G. reptans* showing the characteristic vesicle, but he also, on another plate, gave another figure of Rudolphi's *G. reptans* which in mistake he called *Anthocephalus macrourus* Rudolphi. In the genus *Anthocephalus* Rudolphi, the vesicle is posterior and terminal and not situated in the neck, as it is in the genus *Gymnorhynchus* Rudolphi.

Wagener (1854) also figures a similarly characteristic larva which he too, copying Bremser's mistake, named *A. macrourus*; it is very similar to the one figured by Bremser, but in Wagener's figure the tail-like blastocyst is enormously elongated.

Diesing, in 1850, erected the genus *Pterobothrium* to accommodate encysted larval tetrarhynchids which had four terminal bothridia arranged in the shape of a cross. He placed four species in the genus, namely :—

1. *Pterobothrium macrourum* Diesing.
   ="*Anthocephalus macrourus* Rudolphi (non Bremser)"
2. *P. crassicolle* Diesing.
3. *P. heteracanthum* Diesing.
4. *P. interruptum* Diesing.

No type was designated. Later on Diesing figured *P. heteracanthum* with a vesicle in the neck and he took particular care to point out that his *P. macrourum* was the *A. macrourus* of Rudolphi and not the one figured by Bremser under that name with a vesicle in the neck. In the same paper he also erected the genus *Synbothrium* for an adult tetrarhynchid which had four terminal bothridia arranged in the shape of a cross. The type species was *S. fragile* Diesing, 1850.

In 1855 he both re-described and figured *P. heteracanthum*; his figure of this species resembles very closely those given by Bremser and Wagener for *Anthocephalus macrourus*, *i.e.*, for *G. reptans* Rudolphi. The larva differs from all the other larvae figured, in that when found in certain species of fishes there is a large globular vesicle situated between the head and the very long tail-like blastocyst. In the same paper Diesing changed the name of his genus *Synbothrium* to *Syndesmobothrium* and he described and figured an adult tetrarhynchid having four terminal bothridia arranged in the shape of a cross, which he in 1850 had named *S. fragile*.

Diesing himself called attention to the fact that his two genera *Pterobothrium* and *Synbothrium* were closely related. *Synbothrium* is

'Similar to *Pterobothrium* in the shape of the head, from which it differs, however, in that *Synbothrium* has a segmented body and no receptaculum (vesicle) in the neck.'

Vaullegeard (1899) was of opinion that Diesing's figures of *S. fragile* Diesing, 1850, represented the head of the adult worm, whilst Diesing's figures of *P. heteracanthum* represented the larval stage of the same species.

Diesing (1855) states

> 'In my system of Helminths my first described genus *Pterobothrium* would include Rudolphi's species *A. macrourus* and *A. interruptus*. But since Rudolphi did not give a full description of either of his species, I have made the species *P. heteracanthum*, the type of my new *Pterobothrium*.'

It is thus clear that *P. heteracanthum* is synonymous with Rudolphi's *Gymnorhynchus reptans*, *i.e.*, the *Anthocephalus macrourus* Rudolphi, of Bremser and Wagener, especially since Diesing's figure of the larva, (*i.e.*, of *P. heteracanthum*), also indicates the presence of the characteristic vesicle similar to that figured by both Bremser and Wagener for *A. macrourus*, *i.e.*, for *G. reptans*, Rudolphi.

Syndesmobothrium fragile Diesing, 1850, is undoubtedly the adult form of the larva named by Diesing *P. heteracanthum*, and, in the opinion of the writer, *S. filicolle* Linton, 1899, and *Synbothrium hemuloni* Mac Callum, 1921, are also synonymous with *S. fragile* Diesing, 1850.

Vaullegeard (1899) in his account of *Tetrarhynchus fragilis* (Diesing) states that Bremser's figure of the head of *Anthocephalus macrourus* Rud. represents a different worm from that described by Rudolphi under that name. As noted above, Bremser's figures shew *Gymnorhynchus reptans*, Rudolphi, not *Anthocephalus macrourus* Rudolphi.

It is thus clear that the name of the genus is *Gymnorhynchus* Rudolphi, 1819.

Linton (1889) states that the genus *Syndesmobothrium* Diesing 1855 (=*Gymnorhynchus* Rudolphi, 1819), is characterized by Diesing as follows:—

> 'Body articulate, taeniaeform ; neck tubular, rounded at the base ; head tetragonal, with four terminal prominent bothria attached to head by posterior margin, cruciformly disposed oval, slightly convex, joined with each other at the base by a membrane ; proboscides four filiform, armed each one running through a bothrium (pedicel) excurrent at apex, long, retractile in the neck. Genital apertures marginal (?). In intestines of marine fishes of Tropical America.'

Linton described what he thought was a second species of this genus, viz. *Syndesmobothrium filicolle* Linton, 1889; this, the writer believes to be synonymous with *G. reptans* Rudolphi, 1819.

Definition of the genus Gymnorhynchus

Tentaculariidae in which the head bears four terminal bothridia, usually arranged in the form of a cross, but sometimes pointing anteriorly and without ciliated pits (otocysts). The four proboscides are armed

with hooks. The larval form, in certain species of fishes, is very long and bears a large characteristic vesicle, between the head and the long tail-like blastocyst. In other species of fishes the larval form is simple, consisting of a scolex and a short tail-like blastocyst, the vesicle being absent and the whole larva being enclosed in a simple oval or globular cyst. Type-species *G. gigas*, (Cuvier, 1817).

Gymnorhynchus gigas (Cuvier, 1817) Figs. 40–43

Scolex gigas Cuvier, 1817.
Gymnorhynchus reptans Rudolphi, 1819.
Anthocephalus macrourus Bremser, 1824 and Wagener, 1854.
? *Gymnorhynchus raii* (Rud. ?) Risso, 1826.
Gymnorhynchus horridus, Goods., 1841.
Synbothrium fragile Diesing, 1850.
Pterobothrium heteracanthum Diesing, 1850.
Syndesmobothrium fragile Diesing 1855.
? *Gymnorhynchus elongatus* (Wagener) of Mont., 1893.
Synbothrium filicolle Linton, 1897.
Syndesmobothrium filicolle Linton, 1899.
Tetrarhynchus platycephalus Shipley and Hornell, 1906.
Synbothrium hemuloni MacCallum, 1921.
Vaullegeardia gigas Guiart, 1926.

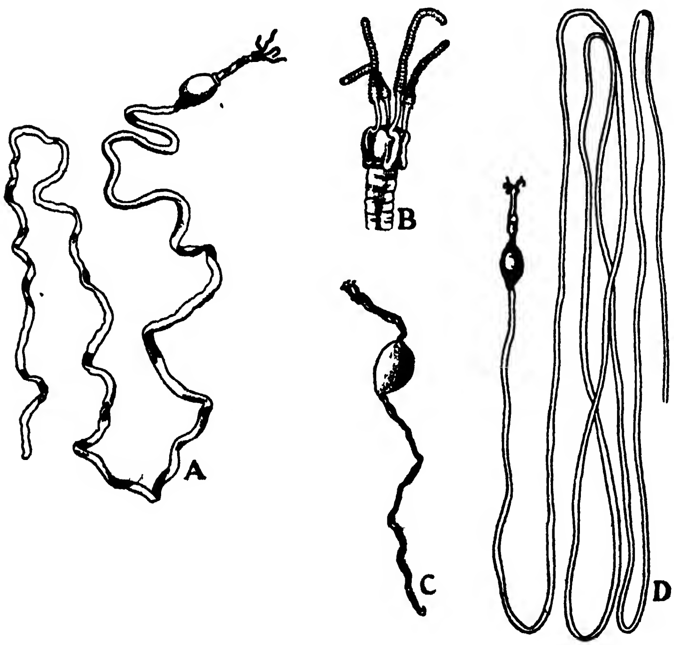


Fig. 40.—*Gymnorhynchus gigas*

A.B = *G. reptans* Rud. (After Bremser).
C = *Antocephalus macrourus* Rud. (After Bremser).
D = *Anthocephalus macrurus* or *reptans*. (After Wagener.)

Diesing's description of *Pterobothrium heteracanthum* Diesing, 1850, which is the larval form of *G. reptans* Rud., 1819, is as follows :—

> 'Body very long, slightly flattened. Receptaculum sub-globular (globular at base ?). Neck thread-like, swollen posteriorly with a narrow base. Proboscides furnished at the back with two or threefold thin hooks, anteriorly with strong visible hooks. Total length up to 5″; proboscides ½″; neck 7″; receptaculum 2″ ; body 2″ and more.'
>
> *Habitat. Micropogon lineatus.* On the surface of the intestine often within a capsule. *Pristipoma coro* ; Brazil. In the flesh (Natterer.)

His description of *Syndesmobothrium fragile* Diesing, 1855 = *Synbothrium fragile* Diesing, 1850, which is the adult form of *G. reptans* Rud., 1819, is as follows :—

> *Segments.* Anterior ones are square at the base, the others almost three times as long as wide, rod-shaped, easily degenerating and breaking up. Length of headwith neck 2″; body 8″; width of neck ½″; body almost ¼.″
>
> *Habitat. Pristis perrottotii* : in intestines. Martio, in Brazil (Natterer)

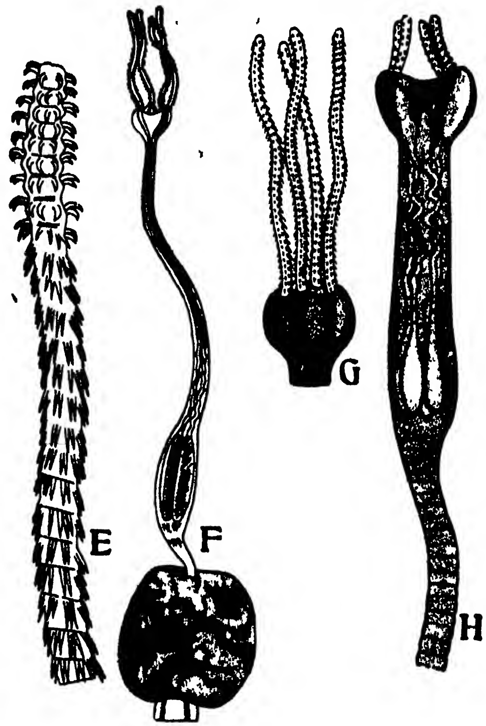


Fig. 41.—*Gymnorhynchus gigas*

E.F = *Pterobothrium heteracanthum* Dies. (After Dies).
G.H = *Syndesmobothrium fragile* Dies. (After Diesing).

Linton's adult specimens were first recorded from *Dasybatus centrura.* Adult or larval stages have since been recorded by him from the following hosts :—*Pomatomus saltatrix*, *Cynoscion regalis*, *Mustelus canis*, *Pomolobus mediocris*. *Lobotes surinamensis*, *Scombcromorus cavalla*, *Scomberomorus regalis*, *Scomberomorus maculatus*, *Paralichthys dentatus*.

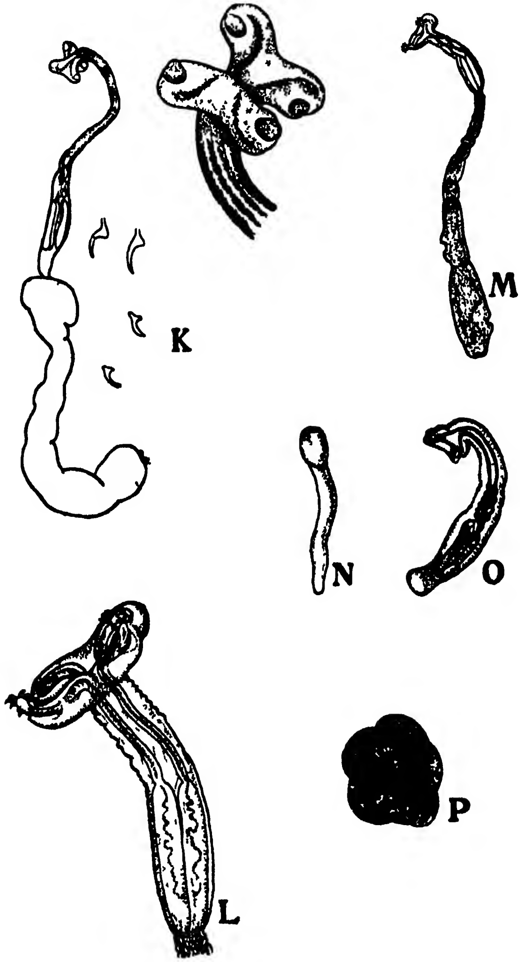


Fig. 42.—*Gymnorhynchus gigas*
K = *Syndesmobothrium filicolle* Lint. (After Linton).
L.M = *Tetrarhynchus platycephalus* Shipley and Hornell. (After Shipley and Hornell).
N.O = *Syndesmobothrium filicolle*- Lint. Cyst and larva (After Southwell).
P—larva from *Arius gagora* × 10 (Orig.).

Shipley and Hornell (1906) described *Tetrarhynchus platycephalus* (=*Gymnorhynchus gigas* [Cuvier 1817]) as follows :—

> 'This is a moderate-sized form, measuring 10 millims. or 12 millims. in length. The head and neck occupy about one-sixth of the whole body length. The head is compressed from front to back and spreads out laterally, having something the appearance of a Toreador's hat. The four-hooked proboscides bend out towards the edge of the hat, and finally emerge at the angles. The hooks are large, sabre-like, and of uniform size.'
>
> 'The body consists of ten or eleven segments, the last two of which are as big as the rest of the body altogether. The proglottides are at first some six times as broad as they are long, but the fourth or fifth proglottis is already square, and the last is perhaps four or five times as long as broad. They are rounded and plump, stouter half way along than at either end, and stouter in front than behind. The most characteristic feature is the genital pore. This is a great cleft which runs almost half across the proglottis and seems to half cut it in two. This appears already in the fourth or fifth proglottis, and gives the appearance of an irregular and abnormal segmentation. The pores are lateral and alternate as a rule, though now and then two will consecutively follow each other on the same side.
>
> 'The diagnosis of *Tetrarhynchus platycephalus* is as follows :—
>
> 'Head much flattened, proboscides coming out of the edges of the flattened head. Hooks uniform in size, sabre-like. Proglottides ten or eleven in number, broader in the middle than at either end. Reproductive pore, resembles a huge cleft, which seems to half cut the proglottis in two; alternate but slightly irregular.'

Pintner (1913) places this species together with *Tetrarhynchus rubromaculatus* Shipley and Hornell, 1906, and *Tetrarhynchus benedeni* (=*T. tenius* van Beneden=*T. gracilis* Diesing) in his genus *Lakistorhynchus*.

From *Dasybatus walga*. Pearl Banks, Ceylon, 7·5·1924.

As the anatomy of the adult worm has not been fully described, further details are given below.

The worm measures 11mm. in length and the maximum breadth is 0·36 mm. It is composed of about 12 segments, the last one measuring 2·9 mm. in length and 0·36 mm. in breadth. There is no neck. The genital pores are very large and irregularly alternate and situated in the posterior third of the segment. They have prominent lips.

Head. The head measures 2·16 mm. in length. Its breadth across the proboscis sacs is 0·45 mm., across the bothridia 0·81 mm. and between the sacs and the bothridia the breadth is 0·36 mm. There are four bothridia, each having a length of 0·27 mm. their free extremities point anteriorly and their sucking surfaces face towards the median longitudinal axis of the worm. The proboscis sacs measure 0·9 mm. in length and 0·17 mm. in breadth, *i.e.*, they are nearly half the length of the entire head. The sacs are peculiar in that the proboscides can be clearly seen lying coiled within them and extending to the posterior extremity. The proboscides are very short and within the head are almost straight. Only one of the proboscides was protruded beyond the head and to a length of 90μ.

Muscular System. The longitudinal muscles are strongly developed and are arranged in fasciae, resembling closely those found normally amongst the various species of *Cyclophyllidea.* The nervous and excretory systems were not investigated.

Testes and Vas deferens. The 6th segment is square; in the 7th segment, there are about 100 well-developed testes; they are oval and lie with their long axes transverse. They extend posterior to the ovary

Fig. 43.—*Gymnorhynchus gigas*

R—head and vesicle (receptaculum) × 15. S—the four bothridia × 160. T—anterior extremity of proboscis × 160. U—another portion of proboscis × 160. V—partly gravid segment × 160 (Orig.).

on both sides and are arranged in two groups, one on each side of the median longitudinal axis. The cirrus pouch is very large, globular and extends more than half way across the segment. As only one worm was available details relating to the cirrus and vas deferens could not be obtained. In Shipley and Hornell's specimens the genital pores were very conspicuous. As the writer's specimen was not fully mature, the genital pores were not so prominent as in their types.

Ovary and Vagina. The ovary is bilobed and situated a little distance from the posterior extremity. Each lobe lies close to the lateral margin of the segment. In total mounts the vagina could not be made out; but in the last segment its terminal portion was seen to run and open posterior to the cirrus pouch.

Vitelline Glands. These are large and prominent, encircling the whole segment, and thus obscuring the genital organs in total mounts. They develop progressively antero-posteriorly.

Uterus. This is a wide sac running along the median longitudinal axis. Anteriorly it turns ventrally, and pushes the ventral wall into a vesicle. It seemed clear that later on the wall would rupture at that point.

Eggs. These are oval and measure 43μ by 26μ. They contain a hexacanth embryo and the shell is devoid of filaments.

The writer has obtained very numerous larval (cystic) forms of this parasite from the mesenteries of the species of Ceylon fish named below, but up to the present the adult worm has only been found twice, in Ceylon.[1]

(1). From *Cybium guttatum.*

Southwell (1912) described the forms thus :—

> 'The head is squarish in front view with a bothridium at each corner. The bothridia are oval or cup-shaped. The larvae agree with Linton's figure of this species save that in the Ceylon specimens the exits of the proboscides were closed. The proboscis sacs were marked with fine criss-cross lines, only visible under high magnifications.'

It is practically certain that one of the larvae described by Shipley and Hornell (1906) from this host (viz. Pl. III, Fig. 43) belongs to the same species.

(2). From *Chorinemus toloo.*

The cysts which occur in this fish are quite unlike those found in *Chirocentrus dorab* and *Hemigaleus balfouri*, *vide infra*; they are somewhat tadpole-shaped having a length of about 12 mm. The cyst has a

1. *Synbothrium hemuloni* MacCallum, 1921, was obtained from a cyst in the thyroid gland of *Hemulon plumiera*. New York, Aquarium. This larval form is clearly identical with *G. gigas* (Cuvier, 1817).

breadth of about 1 mm., whilst the tadpole-like head of the cyst containing the larva measures 2 mm. in length and 1·5 mm. in breadth. A description of this larva is given elsewhere. The writer in 1912 recorded this species from similar cysts in *C. lysan*.

(3). From *Arius gagora*.

Four specimens from cysts, and one unencysted specimen, from *Arius gagora*, from the Sunderbans (Delta of the Ganges), Bengal, India, 23·5·17. The cysts were very long, milky white in colour and tadpole-shaped, measuring from 30 mm. to 40 mm. in length and 2 mm. to 3 mm. in breadth. The " head " of the cyst which contained the larva measured 4·5 mm. in length and 2·5 mm. in breadth. There was a slight constriction between the " head " and the rest of the cyst. The larva itself lies " tied in knots " within the " head " of the cyst ; the blastocyst, to which the head of the worm is attached, measures 20 mm. in length and 0·7 mm. in breadth. The head measures about 4 mm. in length and has a maximum breadth of about 0·5 mm.

The free unencysted larva and its attached blastocyst presented very extraordinary characteristics. It measured 61 mm. in length; the anterior portion was hair-like, and it gradually broadened until the extreme posterior portion had a breadth of 0·7 mm. There is no doubt that in this larva both the head and the blastocyst had elongated to about three times their original lengths. It is interesting to note that Wagener (1854) figures (Plate XVI, fig. 212) a very similar condition in the larva of " *Anthocephalus macrurus* (sic *macrourus*) oder *reptans* " obtained from *Brama raji*.

The head of the worm measured 10 mm. in length and the proboscis sacs 1·6 mm. in length. The breadth across the bothridia was 0·34 mm. and across the proboscis sacs 0·2 mm. The diameter of that portion of the head between the bothridia and the proboscis sacs is 72μ only.

The proboscides and their sheaths had elongated so as to resemble hairs.

The whole condition is artificial, due to extreme elongation, a phenomenon which the writer has noticed before, whilst examining living worms of other species on the Pearl Banks. The proboscides were everted and the hooks were exactly similar to those figured for the same species found under No. 4 below.

(4). From *Chirocentrus dorub* and *Hemigaleus balfouri*.

Two larvae ; one from the former ; Ceylon, Pearl Banks, 1910, and the other from the latter ; off Manapad, 9·2·23.

The cyst in these two hosts is of a most unusual shape. Posteriorly there is a long tail-like portion, measuring about 10 mm. in length and 0·6 mm. in breadth which anteriorly expands into a perfectly globular

thin-walled vesicle having a diameter of 2 mm. From the latter the head proper arises.

Bremser (1824) on Plate XI, fig. 11, gives a picture of *Gymnorhynchus reptans*, shewing the vesicle in question; and on Plate XVII, fig. 1, he figures in mistake a very similar condition of the cystic form in *Antocephalus* (*sic. Anthocephalus*) *macrourus* Rudolphi, 1819; =*Gymnorhynchus reptans* Rud. 1819=*G. gigas*, (Cuvier 1817).

The complete head measures 3·8 mm. in length; its breadth across the proboscis sacs is 0·36 mm., across the bothridia 0·63 mm. and between the two it has a breadth of 0·2 mm. There are four very small bothridia each forming an angle of about 45 degrees with the long axis of the worm, and each having the sucking surface facing the median longitudinal axis of the worm. Each bothridium has a length of about 0·3 mm. The proboscis sacs have a length of 0·9 mm., that is they are about one-quarter the length of the head. Within the posterior part of the head the proboscides are very coiled, but in the anterior part they run a straight course. The free portion of the proboscides (*i.e.*, the part of the proboscides protruded beyond the head) is almost equal to half the length of the head.

The hooks on the proboscides are diagnostic. They arise in groups of about five on each side, a group of five on one side being situated mid-way between 2 groups of 5 on the other side. Superficially only 3 hooks can be seen in each group; by deep focussing five are visible; the bases of all the 5 hooks in each group are close together. The hooks in each group vary in size, the largest measuring about 110μ and the smallest 70μ. They are all delicate. Posterior to each group of five there is a very small hook measuring 17μ. At their anterior extremities the proboscides are armed with long hooks arranged so closely together and with their points directed anteriorly as to resemble a shaving brush.

(5). From the mesentery of *Trichiurus savala*. Indian. Nos. 246 and 247. 22·9·1927, and *Clupea ilisha*, India.

(6). From *Serranus* sp., *Balistes* sp. and *Lutjanus* sp. Pearl Banks, Ceylon.

(7). From liver and mesentery of *Pristis cuspidatus*. Pearl Banks, Ceylon, 7·9·20.

(8). From *Trachinotus botla* (the dart).

The writer has obtained a number of tadpole-shaped cysts from the mesenteries of the above host captured in Australia and presented by Dr. P. A. Maplestone.

Gymnorhynchus malleus (Linton, 1924). Figs. 44 and 45

Synbothrium malleum Linton, 1924
The *Tetrarhynchus erinaceus* of Linton, 1897

Linton, in 1905, described and figured another member of this genus—a larval form—from various species of fish. This parasite had peculiar hooks and he referred to it as *Synbothrium* sp. His description was as follows :—

'1901.—July 11, 1, cestode larva, which is probably to be referred to this species. The cyst was found in the liver, and measured 25 mm. in length and 3 mm. in diameter. The blastocyst was about the same size as the enveloping cyst and was very active. When flattened, marginal sinuous vessels were seen, but no appearance of a larva. The killed specimen measured 14 mm. in length. July 12, a cyst similar to the foregoing found on this date yielded a larva which appears to belong to this species. Dimensions in millimetres : Length 6 ; breadth of head 1·2 ; diameter of neck 0·6 ; length of contractile bulbs 1, diameter 0·27 ; diameter of proboscis, exclusive of hooks, 0·1 ; specimen somewhat compressed.'

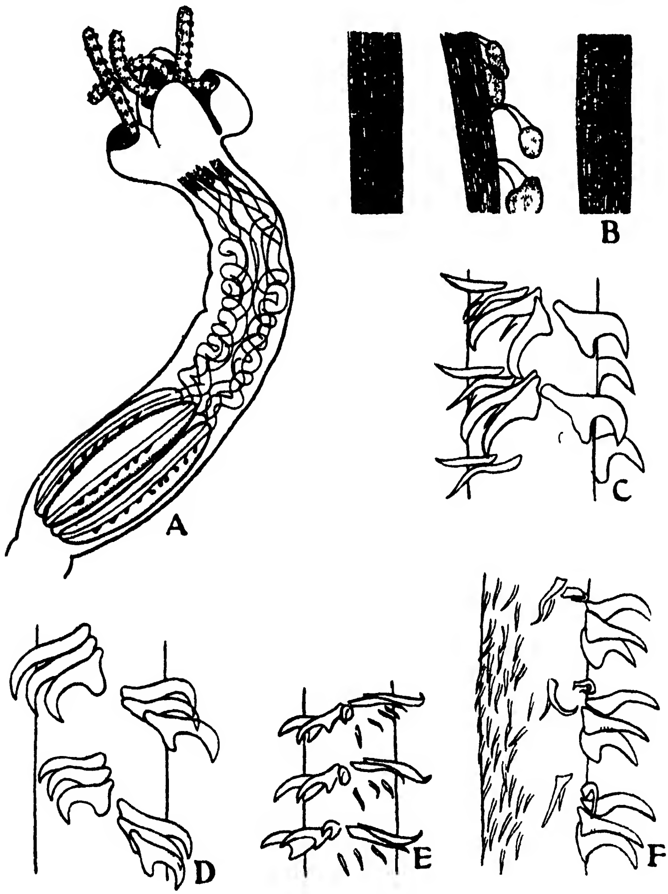


Fig. 44.—*Gymnorhynchus malleus*
A—head and neck × 35. B—enlarged view of proboscis sac showing "granular bodies" attached to small bundles of muscle fibre × 155. C.D—proboscis hooks × 250. E.F—proboscis hooks, basal × 160 (Orig.).

In 1924 Linton described the adult specimen, viz., *Synbothrium malleum* Linton, 1924, from *Dasybatis centrura*, concluding that the larval forms noted above belonged to this new species. He called attention to the fact that the hooks of his *S. malleum* bore a close resemblance both in size and arrangement to those of *Tetrarhynchus erinaceus*. The resemblance is indeed remarkable, but in other respects the heads of the two species in question are entirely different. In fact Linton had named and figured the same larva as *T. erinaceus* (1897 A).

The writer has obtained seven specimens of this species from the spiral valve of *Pteroplatea micrura*, Pearl Banks, Ceylon 2·5·24, and three immature specimens from *Dasybatus kuhlii*, Pearl Banks, Ceylon, 1910.

External Anatomy. The largest worm measured about 6 cms. and contained 47 segments. The greatest breadth was 1·5 mm. There was no neck.

The eighteenth segment was square, measuring 0·7 mm. The last segment contained numerous eggs and measured 1·85 mm. in length and 1·45 mm. in breadth.

The genital pores are irregularly alternate and situated laterally at the base of a deep pit in the posterior third of the segment. Eggs appear suddenly ; they are entirely absent in one segment and very abundant in the succeeding segment. They occurred in the last twelve segments of the largest worm.

Under low magnification the outstanding characters of this worm are :—

1. The longitudinal lines in which the muscle fibres and the vitelline glands are arranged in the mature and gravid segments.

2. The sudden disappearance of the thick uterine wall and the loose appearance of the eggs.

3. The arrangement of the hooks on the proboscides.

Head. This measures 5 mm. in length ; its breadth is as follows : anteriorly across the bothridia 1·26 mm.; across the proboscis sacs 0·95 mm.; between the bothridia and the proboscis sacs 0·75 mm.

There are four small sucker-like bothridia facing anteriorly, each having a diameter of about 0·4 mm.

The proboscis sacs have a length of 1·6 mm. and a breadth of 0·22 mm. Within the head the proboscides are very coiled, but their free portion is very short. The hooks on the proboscides are characteristic of the species ; they have the form and arrangement figured by Linton

(1907, Pl. VII, Figs. 3, 4 and 7) and, as pointed out by that author, they bear a very striking resemblance to those *Tetrarhynchus erinaceus.* The species, however, are entirely different.

Internal Anatomy. Rudiments of the ovary, vagina, uterus and vas deferens are prominent in the third or fourth segment.

Testes and Vas deferens. In stained total mounts, the testes can only be seen in two or three segments, and even then with difficulty, owing to the fact that the vitelline glands develop simultaneously and obscure them. They are fairly numerous, (about 200) and extend posteriorly on each side of the segment, to the ovary. In the fully mature segment the cirrus pouch has a length of 0·72 mm. and a breadth of 0·38 mm.; the cirrus is unarmed and lies in several coils within the pouch. Outside the pouch its course is very short.

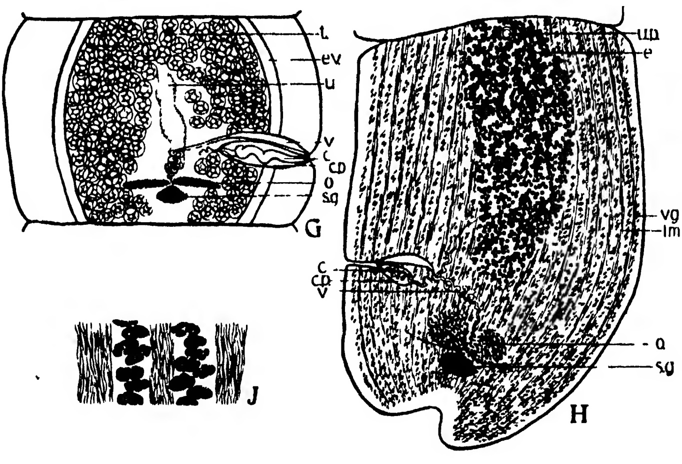


Fig. 45—*Gymnorhynchus malleus*

G—mature segment × 56. H—nearly gravid segment × 33. J—diagram showing disposition of vitellaria and longitudinal muscles ×250 (Orig.).

Ovary and Vagina. The ovary is bilobed, finely granular and situated posteriorly. The vagina in young segments is very coiled ; it opens slightly anterior and dorsal to the cirrus pouch into the deep pit noted above. No seminal vesicle was seen, but just median to the vaginal opening, the vagina dilates into a wide sac.

Vitelline Glands. These extend over the whole of the dorsal and ventral surface of the segment. They are very markedly developed,

even in the immature segments and lie between the bundles of longitudinal muscle fibres. Posteriorly, a duct arises laterally from each side and these unite in the median line and open to the fertilisation canal.

Shell Gland. This is a conspicuous organ situated behind and between the two wings of the ovary, and has a fan-shaped appearance.

Uterus. The uterus in a gravid segment is remarkable. Eggs are absent in one segment and very numerous in the next. It appears to be a central cavity devoid of a proper wall. In immature segments it, as usual, appears as a central stem with thick (glandular ?) walls, but the moment eggs can be seen this thick glandular wall vanishes and the eggs seem to be loose and unconfined, in the central parenchyma. At the anterior margin of the gravid segment in the median longitudinal axis there is a ventral uterine pore.

Eggs. The eggs measure 45μ by 21μ and do not bear filaments. No details relating to the contents of the eggs could be made out.

Linton's adult specimens were from *Dasybatus centrura* and the larvae were from *Cynoscion regalis* and *Pomatomus saltatrix.*

Genus 4. OTOBOTHRIUM Linton, 1890

Linton defined the characters of this genus as follows :—

> 'Body articulate, taeniaeform, head separated from the body by a neck. Bothridia two, opposite, lateral, each with two supplemental ciliated pits at the posterior free angles. Proboscides four, terminal, filiform, armed, retractile in neck. Reproductive apertures marginal.'

These characters are now emended, as follows, to accommodate *O. balli*, n. sp., in which the supplemental ciliated pits are situated in the middle of the margin of the bothridia, and *O. dipsacum*, Linton, 1897, in which there are four bothridia.

The head bears either two opposite lateral bothridia, each with two supplemental ciliated pits, or it bears four bothridia, each with a single ciliated pit. Type-species *O. crenacolle*, Linton, 1890.

Five species are known ; a new species is described below :—

Otobothrium crenacolle Linton, 1890. Fig. 46

Adult worms 14 mm. in length and 9·3 mm. in breadth, comprising about twenty segments. There are two bothridia, each divided into two. The proboscis sacs are very short. The hooks on the proboscides are very small (7 to 8μ), strongly recurved, with a broad base, and of uniform

size, except near the base of the proboscides, where they are very minute (3μ). Larvae in various fishes. Adults in *Carcharias obscurus*, *C. platyodon*, *Scoliodon terraenovae* and *Cestracion zygaena*. Not recorded from India.

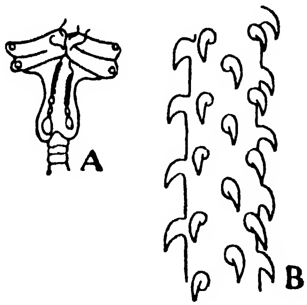


Fig. 46.—*Otobothrium crenacolle*
A--head × 54. B—proboscis hooks × about 900 (After Linton).

Otobothrium dipsacum Linton, 1897. Fig. 47

O. insigne Southwell, 1912. (non Linton).

Larval forms in *Pomotomus saltatrix* and other species of fish. The cyst measures 12 mm. by 6 mm. and contains a pear-shaped blastocyst 8·5 mm. in length and 6 mm. in diameter at the broader end, and tapering to a blunt point posteriorly. The larva measures about 5 mm. in length. There are four bothridia each with a ciliated pit posteriorly. The arrangement of the hooks is characteristic of the species. On each proboscis there is a longitudinal line towards which the shorter diagonal rows of hooks converge on each side. The longest hook measures 50μ.

It will be noted that in the original description of the genus Linton stated that there are two bothridia only. In *O. dipsacum* he states that there are four and this is actually so. But it is clear that each lateral half of the head with its two marginal bothridia forms one complete sucker and acts as a single bothridium.

Several larvae of this species have been obtained from the mesenteries of *Serranus undulosus*, South Silavaturai, Pearl Banks, Ceylon. April 2nd, 1909, T.S. Also from *Diagramma crassispinum*, *Balistes mitis*, *Lutjanus dodecacanthus* and *L. oranatus*, Pearl Banks, Ceylon. 11.12.1924. Dr. Pearson.

The cysts are club-shaped and measure up to 4 cms. in length; the maximum breadth is about 6 mm. The fully-developed cyst is dense jet-black with very firm walls. Very young cysts are not pigmented. All stages between the two conditions are to be seen.

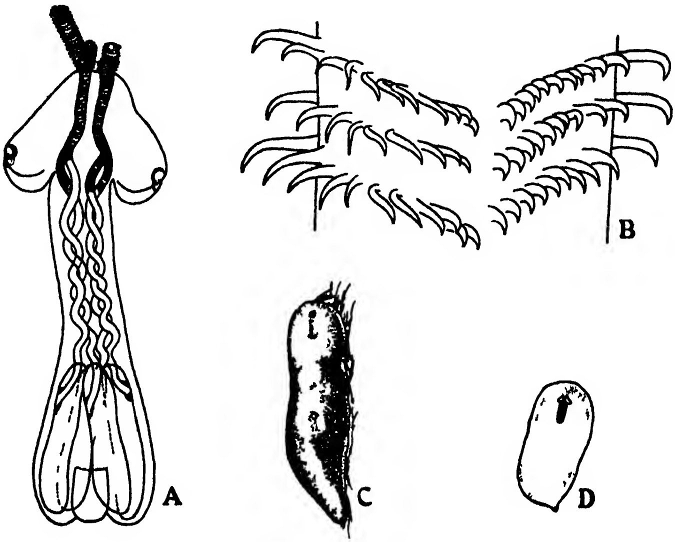


Fig. 47. *Otobothrium dipsacum*
A—larva × 24. B—proboscis hooks × 330. C.D = *O. insigne* Southwell, 1912. Cysts: magnification unknown. (After Southwell).

The larvae attached by their head to one end of the cyst measure between 3 and 4 mm. in length. The four bothridia are in pairs; each has a length of about 1 mm. and bears near its posterior extremity a ciliated sucker-like sac or pit having a diameter of 120 μ. The hooks are all slender and nearly all of the same shape, the longest measuring 47 μ and the shortest 14 μ. The characteristic arrangement of the hooks described by Linton was very pronounced in our specimens.

Southwell (1912) identified these larvae as *O. insigne* Linton, 1905. An examination of the hooks proves them to be *O. dipsacum* Linton, 1897.

Otobothrium insigne Linton, 1905

The immature adult worm measures 10 mm. in length and 0·6 mm. in maximum breadth; it is composed of about 15 segments. The head is elongated, expanding posteriorly into a collar which overhangs the first

segment, a character which it shares with those Tetrarhynchids of the "*lingualis*" group, the proboscis sacs are very small and have their posterior extremities divergent. Hooks of various shapes and sizes, the largest measuring 45 μ. In *Carcharias obscurus*. Not recorded from India.

Otobothrium penetrans Linton, 1907. Fig. 48

Otobothrium sp. Linton, 1905.

Larval forms from muscles of the back and sides, and especially along the dorsal region of, *Tylosurus acus* and *T. raphidoma*. Adult worm in *Cestracion zygaena* and *Carcharias commersonii*.

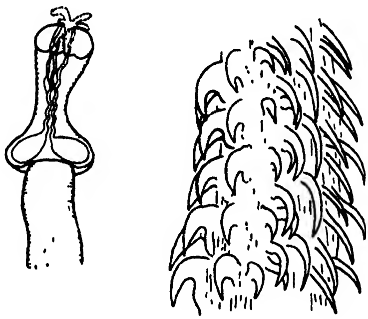


Fig. 48.—*Otobothrium penetrans*
Head and proboscis hooks. (After Linton).

Bothria marginal, widely divergent, with pits characteristic of the genus; neck somewhat elongated, at least longer than the head, stout, widely flaring and emarginate at posterior end; contractile bulbs curved, concave on lateral, convex on medial sides, approximate at their anterior ends but strongly divergent at the posterior ends; proboscides stout and of moderate length; hooks of many different sizes and shapes, the larger ones strongly recurved with rather narrow, unsymmetrical base. A few of the slender hooks near the base of the proboscides are somowhat spirally curved.

'Dimensions in millimetres of alcoholic specimen: Length of scolex to base of bulbs 4; breadth of head 1·75. Another, in balsam: Head compressed, length 1·12, breadth 1·95; approximate length of proboscides 1·8, diameter, including hooks 0·24, excluding hooks 0·15, length of longest hooks 0·09. In another, length of contractile bulbs 1·35, breadth 0·55; approximate length of proboscis 2·25.

'Blastocyst (*plerocercus*): Elongated, white, very irregular in shape; one, somewhat contracted, measured 25 mm. in length.' (After Linton).

The adult worm measures 115 mm. in length and has a maximum breadth of about 2 mm. Genital pores posterior.

The characteristic feature of this species is the shape and position of the proboscis sac. Not recorded from India.

Otobothrium linstowi Southwell, 1912. Fig. 49

Otobothrium magnum Southwell, 1924.

Adult worms from the intestines of *Pristis cuspidatus*, Pearl Banks, Ceylon, February 19th, 1911, and *Rhynchobatus djiddensis*, Pearl Banks, Ceylon, April 25th, 1909.

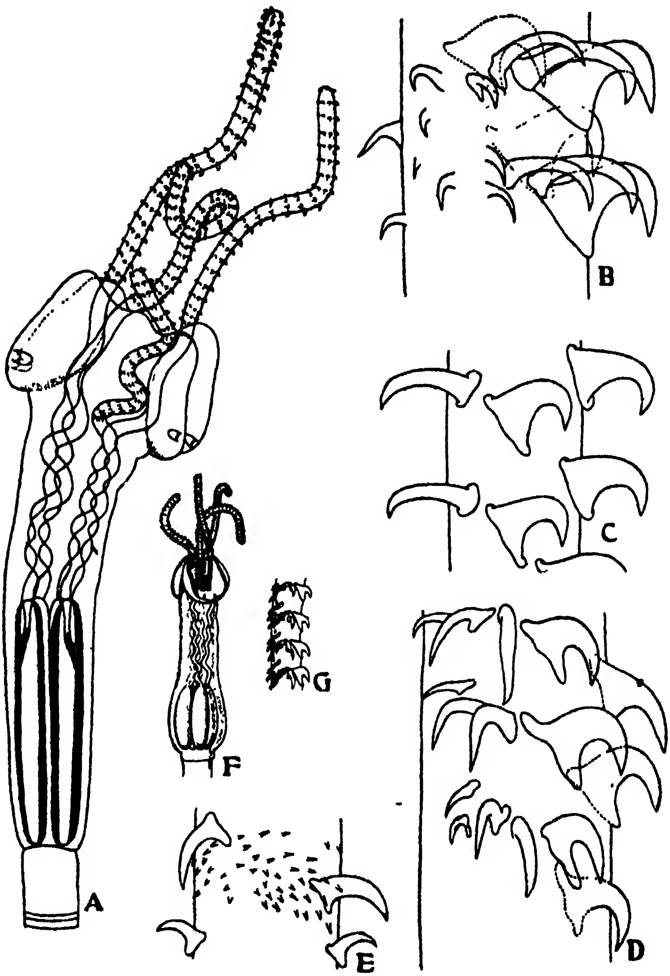


Fig. 49.—*Otobothrium linstowi*

A—head and neck × 46. B.C.D.E—proboscis hooks × 214 (Orig.). F—head and neck × 10. G—hooks (After Southwell). Magnification unknown.

Adult worms 35 mm. in length ; with a maximum breadth of 0·5 mm. and composed of about 50 segments. The head measures from 4 to 4·5 mm. in length and has a maximum breadth of 1·3 mm. The two bothridia each have a length of 1 mm. and the proboscis sacs a length of 1.75 mm., viz., about one-third the length of the entire head. The hooks on the proboscides are spirally arranged on one face only. On the opposite face there are irregularly arranged.

They are of various shapes and sizes as shewn in fig. 49. One face of each proboscis bears spiral rows of large dissimilar hooks, there being from 3 to 5 hooks in each row. The other face bears a number of small delicate hooks of various shapes and sizes arranged quite irregularly. The largest hooks have a length of 80 μ and the smaller ones 20 μ. Towards the tip of the proboscis *all* the hooks decrease in size gradually. The base of each proboscis is not swollen, but it bears a cluster of extremely small and delicate spinules measuring about 9 μ in length. The general anatomy of the worm is described by Southwell (1912).

Otobothrium balli n. sp. Fig. 50

Numerous larval forms from the following sources :—

(1). Very numerous cysts in the submucosa of stomach of *Cybium guttatum*. Quilon, Travancore. Ceylon Marine Biological Survey, 19.4.23. Dr. Pearson.

(2). A few cysts from tissue surrounding gut of *Lethrinus ornatus*. Ceylon Marine Biological Survey. 14.8.20. Dr. Pearson.

(3). A few cysts from mesenteries of *Balistes stellatus*. Pearl Banks, Ceylon. 1910. T.S.

(4). Very numerous cysts from mesenteries of *Aprion pristipoma*. Off Negapatam, India, 7.9.26. Ceylon Marine Biological Survey. Dr. Pearson.

The cysts in *Aprion pristipoma* are oval, and milky white and measured 7 mm. by 4 mm. The inner cyst measures 5 mm. by 2·5 mm. The larva, to which no blastocyst is attached, measures about 1·7 mm. in length and has a maximum breadth of about 1·1 mm. There are two bothridia each having a length of 0·9 mm., *i.e.* more than half the length of the head. They each bear two ciliated pits situated one along each lateral margin, but instead of being posterior they are slightly nearer the anterior extremity of the bothridia than the posterior extremity. The proboscis sacs are oval, having a length of 0·35 mm. and a breadth of 0·1 mm. Their anterior extremities are overhung by the posterior part of the bothridia. The proboscides are very short and lie almost straight within the head. They are armed with small curved, almost uniform,

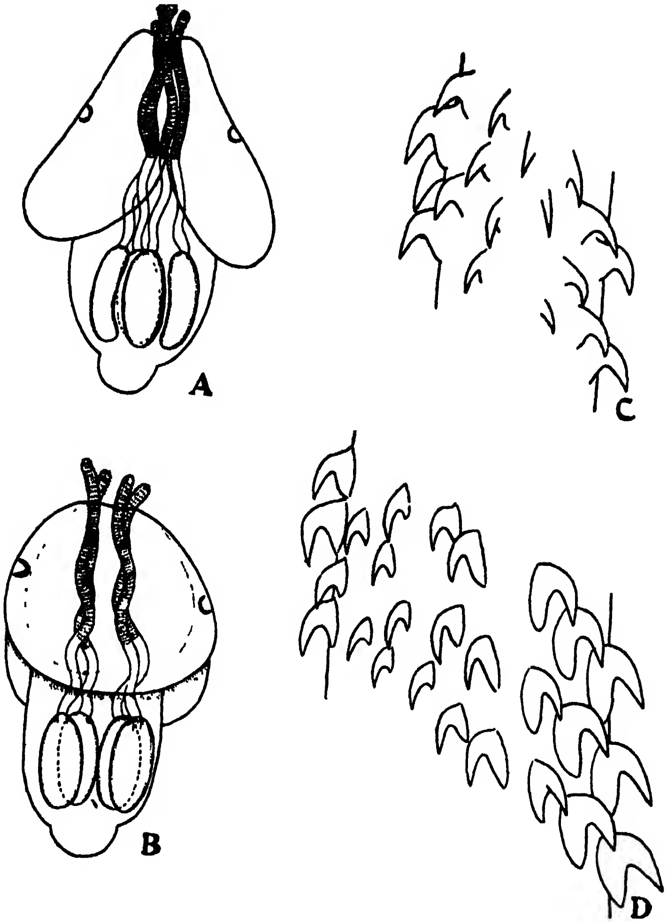


Fig. 50—*Otobothrium balli* n. sp.
A—larva, lateral view. B—larva, dorso-ventral view × 35. C.D—proboscis hooks × 500 (Orig.).

hooks having a rather stout base, and arranged spirally. The hooks vary a little in size, viz. from about 8 to 18 μ. They are densely crowded together.

Key to all the known species of Otobothrium.

	With 4 bothridia....................................	*O. dipsacum*
	With 2 bothridia....................................	1
(1)	Hooks on proboscides all small, 18 μ or less and practically alike....................................	2
	Hooks of various shapes and sizes	3

(2) Proboscis sacs overhung by posterior margin of bothridia .... *O. balli* n. sp.
Proboscis sacs situated well behind posterior margin of bothridia .... *O. crenacolle*
(3) Posterior part of head produced into a collar which overhangs segments .... *O. insigne*
Collar absent 4
(4) Proboscis sacs curved, almost horizontal, their posterior ends being markedly divergent, head broadest posteriorly .... *O. penetrans*
Proboscis sacs straight, lying antero-posteriorly .... *O. linstowi*

LARVAL FORMS OF UNCERTAIN GENERIC POSITION

Tetrarhynchus sp. Fig. 51

(1) Shipley and Hornell described two different Tetrarhynchid larvae from *Cybium guttatum*, Pearl Banks, Ceylon. One was encysted, the other was free.

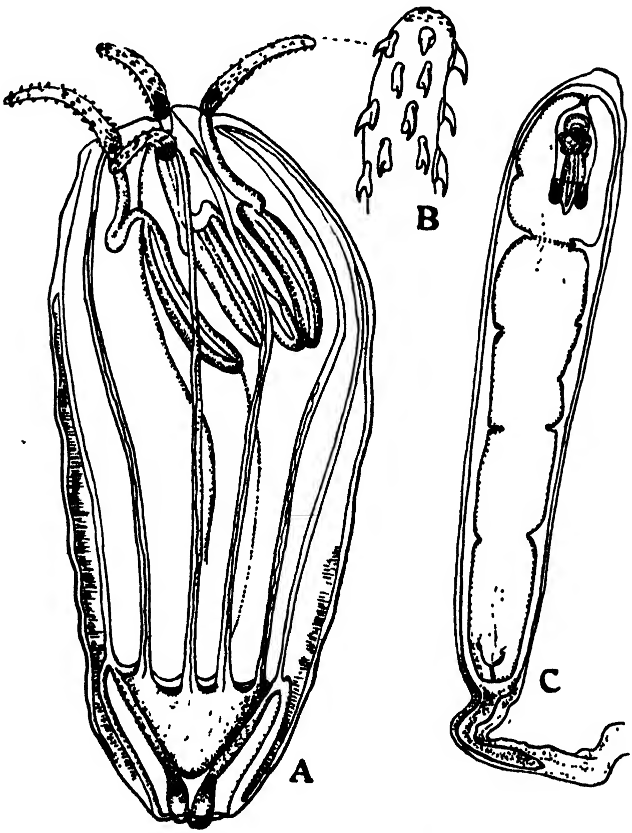


Fig. 51.—*Tetrarhynchus* sp.
A—larva × 25. B—proboscis hooks. C—cyst. Magnification unknown.
(After Shipley and Hornell).

(*a*) In the first species there is a voluminous cyst measuring up to 14 mm. in length and having a breadth of 2·5 mm. They occur in the peritoneum. The larval head is much smaller than the one described below ; it is invaginated, and the walls of the cavity in which it lies, meet, and all but fuse. They are then continued backwards as the wall of the cyst, which is contracted here and there. Posteriorly the exit of the excretory system is visible.

(*b*) The one without a cyst is egg-shaped, measuring 4 mm. in length and having a maximum breadth of 2 mm. The " tail or posterior end is ensheathed in a circular fold, like a petticoat, and from it runs up a number of ribs or ridges which fade out in the head. The teeth on the proboscides are large and stout, and comparatively sparse."

(2). It is impossible to identify the larval Tetrarhynchids mentioned by Shipley and Hornell, 1906, found in *Chirocentrus dorab* (Fig. 52), *Lutjanus annularis*, *Diagramma* sp., and *Sphyraena commersoni*. It seems probable that the larva in the last named host is *Gymnorhynchus gigas* (Cuvier, 1817).

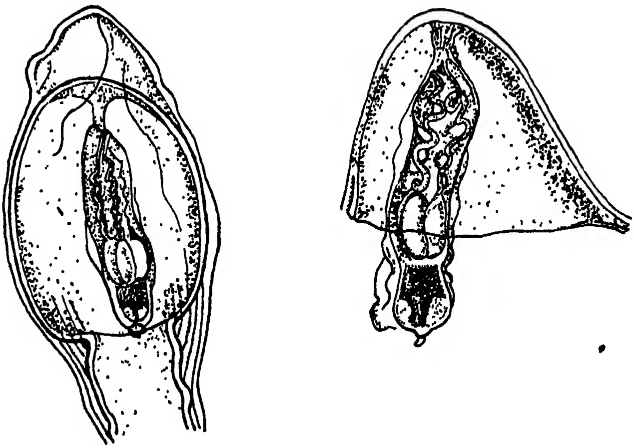


Fig. 52.—*Tetrarhynchus* cyst.
Magnification unknown. (After Shipley and Hornell).

(3). Shipley in 1903 recorded Tetrarhynchid larvae from a snake *Enhydrina valakadien* in Siam. Meggitt, 1927, records a similar larva from a snake (*Hurria rhynchops*) in Burma. Moghe, 1926, has recorded a larval Tetrarhynchid from *Barbus sophore* in India.

(4). A collection of ten *Tetrarhynchid* cysts from the mesenteries of *Balistes mitis*, *Balistes stellatus*, *Lutjanus* sp. and *Serranus undulosus*, Pearl Banks, Ceylon, 1910, T.S. were examined. The cysts were roughly

oval, milky white, or light brown and measured 10 mm. by 3 mm. An unidentified larval nematode about 10 mm. to 12 mm. in length was found attached to the outer cyst wall in every case. and in each instance the cestode larva within the cyst had degenerated into a brownish unre'ognisable mass.

The **Ilisha parthenogenetica** of Southwell and Prashad, 1918. Fig. 53

When describing this parasite in 1918 it was believed that the worm was an adult degenerate Cestode which was peculiar in having a special mode of reproduction, viz., parthenogenetic reproduction. I have recently re-examined the original material and some fresh material and have again fully considered, in view of this further work, whether the conclusions then arrived at were justified.

The method of reproduction exhibited by this worm is very similar to the production of the germ-balls in the sporocysts of Trematodes like *Fasciola hepatica*. The resemblance, however, is purely superficial, for whereas in *I. parthenogenetica* the parthenogenetic development leads directly to the production of forms exactly similar to the parent, in the Trematode the asexual reproduction results in the formation of rediae, and finally of cercariae, both of which are very different from the sporocyst in which they are produced.

The exact manner in which endogenous embryos arise in larval Cestodes described by Hornell (1906), Willey (1907) and Southwell (1910) is not known, as in all these cases the endogenous larvae were described from fully developed forms and in no case had the intermediate stages been observed. In the parasite of the Indian Shad, however, it was possible to study the development of the parthenogenetically developed forms. The method of endogenous reproduction, described by the authors referred to above, does not materially differ from what occurs in *I. parthenogenetica*, and accordingly it is clear that the parasite of the Indian Shad is not an adult degenerate Cestode but a Plerocercoid larva, the adult of which is unknown.

The larvae described by Hornell, Willey and Southwell were all found in the Pearl Oyster (*Margaritifera margaritifera* Linn.) or the Window-pane Oyster (*Placuna placenta* Linn.) of Ceylon. Haswell and Hill (1894) had previously described a similar worm with an identical mode of reproduction from an Australian earthworm. The only two instances of the occurrence of such a sexual modes of reproduction in the Cestode parasites of the Vertebrates are those described by Ijima (1905) and Beddard (1912). The parasite of the Indian Shad provides the first instance of endogenous reproduction taking place in a Plerocercoid form found parasitic in any fish.

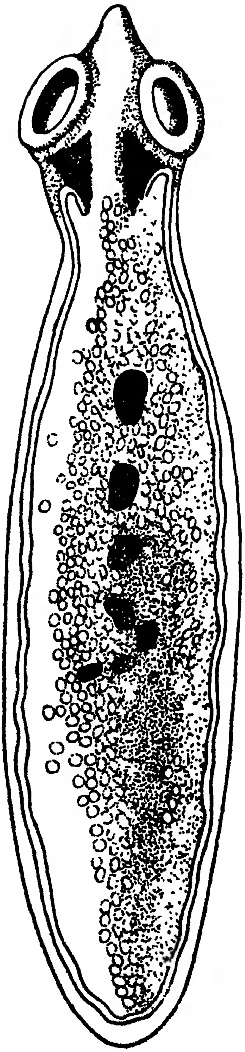


Fig. 53. ***Ilisha parthenogenetica***
Magnification unknown. (After Southwell).

Larval Cestode from Medusae. Fig. 54

A large number of larval Cestodes have been recorded from the umbrella of a Rhizostomous medusa (*Acromitus rabanchatu*), Barkuda Island, Chilka Lake, August 21, 1920.

The larvae are cylindrical, with broad rounded extremities, and they measure from 2 mm. to 2·5 mm. in length ; the diameter is 340 μ (figs. *a* and *b*). They lie in cavities in the host, but are not surrounded by a definite adventitious cyst, although there is a slightly marked condensation of host-tissue round them.

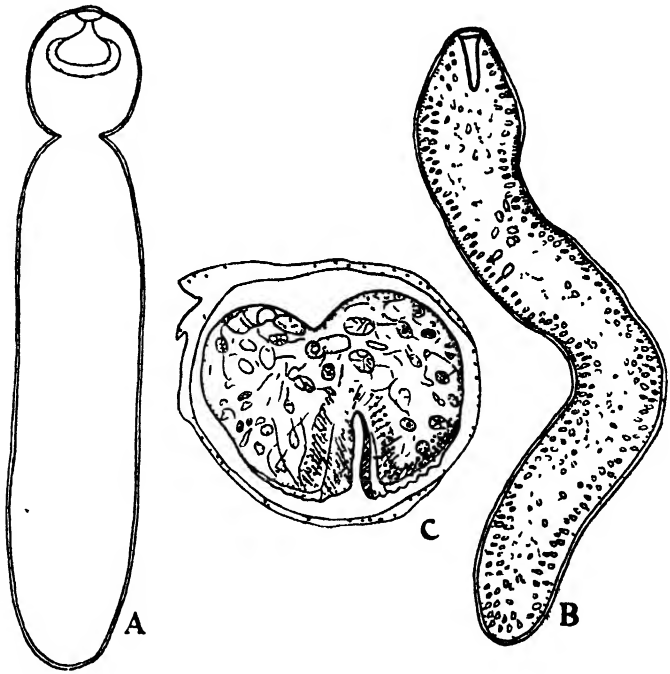


Fig. 54.—*Plerocercoid* larva
A.B—× 69. C—× 143. (After Southwell).

Both fresh and preserved specimens have a milky white colour and can be seen easily with the naked eye, especially in the fresh condition. The larva is solid and is covered with a definite cuticle. There is a very definite sub-cuticular tissue made up of a series of small spindle-shaped cells, closely packed together, the nuclei of which stain deeply (fig. *c*).

Internally the larva consist of a stroma framework enclosing a few large cells which in cross section measure about 38 μ by 25 μ. Their antero-posterior length was not determined.

These cells are at first granular, but, later on, calcareous corpuscles develop within them and gradually fill the cell. Eventually the calcareous corpuscles (which are very large and numerous) become free, and the cells which secreted them are no longer visible, being replaced by others apparently from the sub-cuticular layer.

The anterior extremity is marked by a deep pit, lined with extremely small spinules. The base of this pit is thickened, the thickened area consisting of very numerous small elongated cells with well defined nuclei. As in many other Cestoda the head develops from the base of this pit. In our specimens development had not proceeded beyond the formation of this pit and no trace of the head was to be seen. The differences noted in the specimens were confined to the size and shape of the pit. In one or two instances a constriction appeared immediately behind the rudimentary head, separating the worm into two parts (fig. *a*).

There can be no doubt that the parasites are Plerocercoid larvae. It is impossible to identify or classify them at this stage of their development.

As far as I am aware, no Cestode larvae have been recorded previously from animals so low in the zoological scale as Medusae.

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EXPLANATION OF TEXT FIGURES

The following reference letters are used in the figures throughout this paper :—

c.	cirrus	*p. b.*	proboscis bulb
c. p.	cirrus pouch	*r. s.*	receptaculum seminis
c. m.	circular muscles	*s. g.*	shell gland
d. m.	dorso-ventral muscles	*t.*	testes
e.	eggs	*u.*	uterus
e. v.	excretory vessel	*u. p.*	uterine pore
l. m.	longitudinal muscles	*v.*	vagina
n.	nerve	*v. g.*	vitelline glands
o.	ovary	*v. d.*	vas deferens
o. f.	oblique fibres		

APPENDIX

LIST OF SPECIES RECORDED FROM CEYLON AND INDIA

Genus **Tentacularia** Bosc, 1797

(a) *Adult worms*

PARASITE	HOST
Tentacularia macrocephala (Shipley and Hornell, 1906	*Dasybatus walga. Dasybatus kuhlii. Rhynchobatus djiddensis.* (not Eysenh., 1829).
Tetrarhynchus ruficollis of Shipley and Hornell, 1906, not Eysenh., 1829. See *Tentacularia macrocephala.*	
Tentacularia macropora (Shipley and Hornell, 1906)	*Dasybatus uarnak. Stegostoma tigrinum. Galeocerdo arcticus. Dasybatus* sp.
Tentacularia aetobatidis (Shipley and Hornell, 1906)	*Stoasodon narinari*
Tentacularia rhynchobatidis (Shipley and Hornell, 1906)	*Rhynchobatus djiddensis*
The larval form of this species is found in	*Balistes stellatus.*
Tentacularia gangetica (Shipley and Hornell, 1906)	*Carcharias gangeticus.*
Tentacularia carcharidis (Shipley and Hornell, 1906)	*Carcharias melanopterus.*
Pintner says this species belongs to the genus *Otobothrium* and is probably *O. crenacolle.*	
Tentacularia leucomelana (Shipley and Hornell, 1906)	*Dasybatus sephen. Dasybatus kuhlii Rhynchobatus djiddensis.*
Tentacularia rubromaculata (Diesing, 1863)	*Dasybatus walga.*
Tentacularia minuta (van Ben., 1858)	*Carcharias* sp.
	Rhina halavi.
Tentacularia spinulifera (Southwell, 1911)	*Rhynchobatus djiddensis.*
Tentacularia longispine (Linton, 1890)	*Dasybatus walga.*
Tentacularia unionifactor (Shipley and Hornell, 1904)	*Rhinoptera javanica. Dasybatus* sp. *Ginglymostoma concolor*
Larvae in *Margaritifera vulgaris.* The identity of this parasite is a matter of considerable uncertainty.	

PARASITE	HOST
Tentacularia rossii (Southwell, 1912)	*Dasybatus kuhlii.*? *Dasybatus walga.* *Rhynchobatus djiddensis.* *Stoasodon narinari.*
Tentacularia johnstonei n. sp.	*Dasybatus sephen.*
Tentacularia michiae n. sp.	*Rhynchobatus djiddensis.* *Dasybatus sephen.* *Dasybatus kuhlii.*
Tentacularia obesa n. sp.	*Dasybatus sephen.*
Tentacularia binunca (Linton, 1909)	*Dasybatus* sp. ? *walga.*
Tentacularia ilisha (Southwell and Prashad, 1918)	*Carcharias gangeticus.*

(b) *Larval forms*

Tentacularia spiracornuta (Linton, 1907)	*Psettodes erumei.* *Caranx* sp. *Thynnus* sp.
Tentacularia pillersi n. sp.	*Cossyphus axillaris* *Lutjanus argentimaculatus* *Drepane punctata.* *Diagramma* sp. *Serranus undulosus.*
Tentacularia rhynchobatidis (Shipley and Hornell, 1906)	*Balistes stellatus.*
Tentacularia unionifactor (Herdman and Hornell, 1903)	*Margaretifera vulgaris.*
Tentacularia ilisha (Southwell and Prashad, 1918)	*Clupea ilisha.*
Tentacularia macfiei n. sp.	*Cybium guttatum.* *Cossyphus axillaris.* *Trichiurus savala.* *Chorinemus lysan.* *Chorinemus toloo.* *Lutjanus argentimaculatus.* *Lutjanus gibbus.* *Serranus stellatus.* *Balistes* sp. *Balistes mitis.* *Serranus undulosus.* *Psettodes erumei.*
Tentacularia pinnae (Shipley and Hornell, 1904)	*Balistes stellatus. B. mitis, B. undulatus.* *Pinna* sp.
Tentacularia gangetica (Shipley and Hornell, 1906). The identification of this larvae is a matter of considerable uncertainty.	*Sphyraena jello.*

Genus 2. **Tetrarhynchus** Rudolphi, 1809

(a) *Adult worms*

Tetrarhynchus perideraeus (Shipley and Hornell, 1906) Larvae in *Balistes stellatus, B. mitis.*	*Carcharias gangeticus.* *Ginglymostoma concolor*
Tetrarhynchus equidentatus (Shipley and Hornell, 1906)	*Dasybatus walga.*

PARASITE	HOST
Tetrarhynchus herdmani (Shipley and Hornell, 1906)	*Dasybatus walga.* *Rhynchobatus djiddensis.*
Tetrarhynchus minimus (Linstow, 1904) Probably *Gymnorhynchus gigas.*	*Taeniura melanospila.*
Tetrarhynchus shipleyi n. sp.	*Ginglymostoma concolor*
Tetrarhynchus ceylonicus n. sp. (immature)	*Ginglymostoma concolor*
Tetrarhynchus matheri n. sp. (almost mature) ? Larvae in *Balistes* sp.	*Ginglymostoma concolor*
Tetrarhynchus pearsoni n. sp.	*Cybium guttatum.*

Larval forms

PARASITE	HOST
Tetrarhynchus balistidis (Shipley and Hornell, 1904)	*Balistes mitis.* *B. undulatus and* *B. stellatus.*
Tetrarhynchus sp. (Shipley and Hornell, 1906)	Encysted in *Balistes mitis* Identification not made.
Tetrarhynchus sp. (Shipley and Hornell, 1906) It is probably *Tentacularia macfiei* n. sp. described in this paper.	Encysted in *Balistes mitis.*
Tetrarhynchus perideraeus (Shipley and Hornell, 1906)	*Balistes mitis.* *Balistes stellatus.*
Tetrarhynchus spp. (Shipley and Hornell, 1906) (1) Encysted. (2) Unencysted. The above two species are almost certainly larval forms of *Gymnorhynchus gigas.*	*Cybium guttatum.*

Genus **Otobothrium** Linton 1890

(a) *Adult worms*

PARASITE	HOST
Otobothrium linstowi (Southwell, 1912)	*Pristis cuspidatus.* *Rhynchobatus djiddensis.*
Otobothrium crenacolle (Linton, 1890)	

Larval forms

PARASITE	HOST
Otobothrium dipsacum (Linton, 1897)	*Balistes stellatus.* *Diagramma crassispinum.* *Balistes mitis. Balistes stellatus.* *Lethrinus ornatus.* *Lutjanus dodecacanthus.* *Stromateus niger. Serranus undulosus.*
Otobothrium balli n. sp.	*Cybium guttatum.* *Lethrinus ornatus.* *Balistes stellatus.*

Genus 4. *Gymnorhynchus* Rudolphi, 1819

(a) *Adult worms*

PARASITE	HOST
Gymnorhynchus gigas (Cuvier, 1817)	*Dasybatus walga.*
Gymnorhynchus malleus (Linton, 1924)	*Pteroplatea micrura.* *Dasybatus kuhlii* (Ceylon) *Dasybatus centrura* (in America).

(b) *Larval forms*

Gymnorhynchus gigas (Cuvier, 1817)	*Cybium guttatum.* *Chorinemus toloo.* *Arius gagora.* *Chirocentrus dorab.* *Hemigaleus balfouri.* *Trichiurus savala.* *Pristis cuspidatus.* *Serranus* sp. *Balistes* sp. *Lutjanus* sp. *Clupea ilisha* in India. Other hosts in Australia and America.
Gymnorhynchus malleus (Linton, 1924)	*Pteroplatea micrura Dasybatus kuhlii* *Cynoscion regalis.* *Pomatomus saltatrix* (America).
The *Ilisha parthenogenetica* of Southwell and Prashad, 1918	Plerocercoid reproducing asexually.
Plerocercoid larvae	From the umbrella of the Jellyfish (*Acromitus rabanchatu*).

It is impossible to identify the following :—

Tetrarhynchus sp. Shipley and Hornell, 1906.	Encysted in *Chirocentrus dorab.*
Tetrarhynchus sp. Shipley and Hornell, 1906	Encysted in *Diagramma* sp.
Tetrarhynchus sp. Shipley and Hornell, 1906	Encysted in *Lutjanus annularis.*
Tetrarhynchus sp. Shipley and Hornell, 1906	Encysted in *Sphyraena commersoni.*

From snakes :—

Tetrarhynchus sp. (Shipley, 1903)	*Enhydrina valakadien,* Siam.
Tetrarhynchus sp. (Meggitt, 1927)	*Hurria rhynchops,* Burma.

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